

The Science Teacher Enhancement via Extension (SciTEE) Project: An Impact Study Using the Model of Change

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Abstract

Using the theory of change, the impact of the Science Teachers Enhancement via Extension (SciTEE) Project of a state university in the northern part of Luzon, Philippines, was evaluated. Through the mixed method of research, the study investigated the extension profile, project level of implementation, outputs, outcomes, and impact after being implemented for five years. The participants of the different extension activities were the respondents. The process of triangulation was utilized to gather the data needed. Through the project, the beneficiaries enriched their knowledge of selected science content, developed their ICT skills in teaching, acquired knowledge and skills on the proper use of science equipment, and developed their skills in research and in making instructional materials. The Project contributed to the capacity building of the beneficiaries, their social and economic development, lifelong learning skills, and generally contributing to the global goal of preparing teachers for 21st-century learning.

Keywords: 21st-century teaching skills, model of change, extension program, teacher enhancement, impact assessment.

1. Introduction

The quality of science education needs to be improved in many countries worldwide based on the Programme for International Student Assessment (PISA) reports as reported by the Organization for Economic Cooperation and Development (OECD) (Mujtaba et al., 2022).

In the Philippines, there has been growing concern over students' performance in science subjects in recent years. Despite ongoing efforts to enhance science education, students' achievement levels in this vital discipline consistently fall short of international standards. This is supported by the analysis conducted by Balagtas et al. (2019),

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revealing that the participation of the Philippines in the Trends in International Mathematics and Science Study (TIMSS), an extensive global assessment in mathematics and science, consistently exposes a dismal performance of its students in all cycles. The recent 2019 TIMSS results showed that the Philippines scored 249 in science. This score reflects a decline compared to the country's performance in 2003 and falls below the average score (Bernardo, ABS-CBN News, 2020).

This concern has been corroborated by the PISA as reported by the Organization for Economic Cooperation and Development (OECD, 2019). The average scientific literacy score for Filipino students was 357, which is significantly below than the OECD average of 489. Recognizing the urgency of addressing these issues and gaps in achieving quality basic education, the Department of Education (DepEd) in the Philippines acknowledges the need for action (Department of Education, 2019).

Furthermore, the 2018 National Achievement Test (NAT) in the Philippines revealed a region with an average science score of 28.42, falling significantly below the standard score of 75 (Department of Education Region 2, 2018). The underperformance of students in science carries significant implications for the country's future. In a society increasingly driven by technology and knowledge, scientific literacy is crucial for individuals to thrive and contribute to national development. Knowledge of the sciences expands job options and fosters the critical-thinking, problem-solving, and innovative abilities necessary to tackle complex global concerns.

Critical thinking takes center stage in scientific inquiry, as emphasized by Hart (2023). Education scholars such as Ennis (2011) and Facione (2011) highlight its pivotal role, acting as both a liberating force and a prerequisite for upholding the ideals of a democratic society. By fostering critical thinking, individuals are propelled towards civic engagement, effective decision-making, and the ability to adapt swiftly to a rapidly evolving world—a mission shared by universities worldwide. Moreover, critical thinking is recognized within international frameworks for 21st-century competencies (Sustekova et al., 2019), further underscoring its importance.

In facing the challenges and demands of the 21st century, especially in scenarios requiring problem-solving and critical thinking, developing critical thinking skills becomes crucial, as emphasized by Farillon (2022).

Cultivating these essential skills relies on teachers' capacity to offer students ample opportunities for their development, particularly in the context of the 21st century. Geng (2021) emphasizes that teachers face increasingly challenging roles in this era, requiring competence in digital technologies. By leveraging modern technology, teachers can

stimulate students' imaginations and interests, thereby nurturing their critical thinking abilities (Starko, 2013). It is worth noting that teachers' impact accounts for 75% of schools' overall effect on student achievement (Rivkin et al., 2005).

Returning to the PISA (2018) results, it is evident that Asian nations like China and Singapore secured the top positions, ranking first and second, respectively, in math, science, and reading. In contrast, seven countries saw declining performance, such as Australia, Finland, Iceland, Korea, the Netherlands, New Zealand, and the Slovak Republic (OECD, 2019). Conversely, the Philippines has consistently exhibited poor performance in mathematics and scientific literacy, positioning second from the bottom among 79 countries.

Several factors contribute to the underperformance of students in science subjects. These include ineffective teaching methodologies, students' negative attitudes toward science subjects, and a lack of resources such as textbooks and well-equipped laboratories (King'aru, 2014). Ngema (2016) also highlights teachers' insufficient specialized content knowledge as a contributing factor.

In the local context, factors like inadequate teacher training, unfavorable teaching and learning environments, curriculum misalignment, and insufficient pedagogical strategies further influence poor performance in science (Komba & Kira, 2013; Rabino, 2014). Consequently, there is a pressing need to prepare science teachers for 21st-century teaching approaches. This worrisome trend underscores the importance of targeted interventions that address the challenges faced by science teachers, enhancing their capacity to educate students effectively. One potential solution is the implementation of mentoring activities.

Addressing these challenges and improving science education requires proactive measures to support and empower science teachers, ultimately benefiting the youth. Through mentoring initiatives and tailored interventions, teachers can receive the necessary guidance and resources to enhance their teaching practices and create a conducive learning environment for students.

One of the four primary roles of higher education institutions, or State Universities and Colleges in the Philippines, is extension service. According to CMO No. 08, s. 2010, extension service is the dissemination and transfer of knowledge and technology to industries and target audiences with the goal of enhancing HEIs' academic research programs while also assisting the community in improving output and quality of life. Extension is the practical application of research outputs to the target beneficiaries to improve their lives (Alcala, 2016).

The Higher Modernization Act of 1997, or Republic Act 8292, requires Philippine institutions such as State Universities and Colleges (SUCs) to conduct research and extension programs to help the country's development. In her remarks during the celebration of the 2010 Outstanding HEI Extension Programs, Chairperson Licuanan, as cited in an article published by Malipot (2011), stressed the significance of performing extension work that is relevant and responsive to the community's needs.

As a result of this mandate, Philippine HEIs/ SUCs are cognizant of their important social obligations, which translate into the institution's involvement in local development. They establish an extension office and provide relevant and responsive activities to the community's needs. They provide services, programs, initiatives, activities, research-based information, or technology to the less fortunate or those living in depressed and rural locations, all aligned with the school's academic offerings.

The University of Northern Philippines, a state university, has an Extension Agenda that is based on the Millennium Development Goals (MDGs) and the governance initiatives of the university. In line with the university's vision to be the Center of world-class excellence for relevant extension services, it provides extension activities dubbed as "Science Teachers Enhancement via Extension (SciTEE) Project." The Project is designed to cater to the needs of science teachers by providing them with relevant training and activities that will serve as their mobile in facing the challenges of 21st-century teaching and learning.

The SciTEE Project has five major components: capacitating science teachers on content and teaching strategies, utilizing ICT in teaching, transfer of technology using science apparatus, research mentoring, and instructional materials development. These components were based on the results of the needs assessment surveys conducted. In its four years of implementation, the university conducted several and varied extension activities in different adopted schools. With the many activities conducted, A lot of effort and non-human resources were invested in implementing the Project. Hence, it is imperative to know if it is worth the effort and the money invested in the Project. The authors spurred an interest to assess the impact of the SciTEE Project on the lives of the teacher beneficiaries, particularly the science teachers.

The findings of this study may be a basis for a re-planning of the extension activities, which may contribute to a sustainability plan. The best practices of the SciTEE Project may serve as a basis for improving the other extension programs of different academic programs in the university.

The study's main objective is to assess the SciTEE Project. It determined the following: extension profile, level of implementation of the Project, its outputs, outcomes in capacity building, improvement of the school science laboratory room, and social and economic development of the beneficiaries, and its impact on the development of teachers for 21st-century science teaching and learning.

Literature Review

The study is anchored on the theory of readiness for change, social cognitive theory, theory of planned behavior, and theory of evaluation.

The theory of readiness for change by Prochaska et al. (1992) demonstrates that people go through five stages as they adopt a new behavior or belief. These stages are pre-contemplation, contemplation, action, maintenance, and termination. An adult can learn and start off where they are by using this theory. This hypothesis identifies the intended behavior's stage status. The theory of readiness for change is linked to social cognition and the theory of planned behavior.

In Bandura's social cognitive theory, as cited in the University of Maryland Extension Manual (2013), the "do-ability" aspect that gauges the capacity to carry out the desired activity is self-efficacy. The feeling of control, which includes having adequate skill and confidence to act, has an impact on one's ability. The secret to acting is having self-confidence. The success of an extension program depends on the beneficiaries' ability to absorb the knowledge learned and their competencies to act, utilize, or put into practice what they have learned.

The theory of planned behavior of Ajzen (1985) holds that intentions control all actions. This theory describes how attitude and perceived control affect intent and how behavioral choice impacts conduct. People who believe they can perform the behavior are helped by this belief. It emphasizes the value of having supportive relationships with significant others who can aid in behavior modification. In this study, this theory helps explain how the support and assistance of the extensionist influence the beneficiaries' behavior. It also describes how the extensionist affects the beneficiaries' thinking, attitude, and skills.

The theory of utilization-focused evaluation by Patton (1997) and the theory of action by Lewin (1946), as cited in the University of Maryland Extension Manual, are the theories program developers used for program assessment. These theories clarify how to evaluate outcomes (summative evaluation) and how the planning, carrying out, and

evaluating results and communications processes are working. The philosophy of action describes how to bring about desired outcomes.

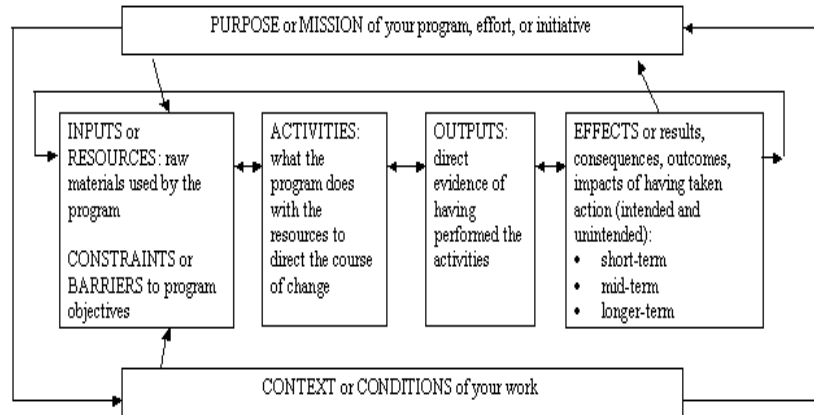
On impact assessment, Edwards (2000) observed growth and development's potential impacts on Wisconsin communities. Communities have traditionally seen growth as good and beneficial. Communities are becoming more conscious, though, that costs might come with change. Bornstein (2010) emphasized that impact assessment provides a framework for addressing community development.

When a specific project is planned and anticipated for a community, a social impact assessment is conducted. This is especially true if it is employed as part of a process for strategic planning or in project development. The assessment results may be used to monitor the effects of ongoing projects and, again, in theory, can help development agencies verify that their activities are not negatively affecting development (Canan & Hennessy, 1985). It can also apply to individual projects where this is appropriate (Edwards, 2000). Social impact refers to the effects on human populations of any governmental or private acts that change how people interact, live, work, play, organize to meet their needs, and generally function in society. (Inter-organizational Committee on Guidelines and Principles for Social Impact Assessment, May 1994).

In a state university in the Philippines, the Community Extension Program of the College of Nursing demonstrated that it was great at treating patients with respect during medical consultations and providing the appropriate medication to the appropriate patient. The college was very good in providing health education to its clientele. Gaining enough knowledge and understanding about the health condition of the community at large ranks first in the percentage distribution for the improvement of the recipients' quality of life (Bagui & Magtibay, 2006).

Presented in Figure 1 is the model of change. The model is a representation of how a project or initiative is planned to function. It helps plan, implement, and evaluate an initiative. It helps stakeholders agree on short-term and long-term objectives during the planning process, outline activities and actors, and establish clear criteria for evaluation during the effort. (Milstein & Chapel, n.d.)

Figure 1. The Model of Change

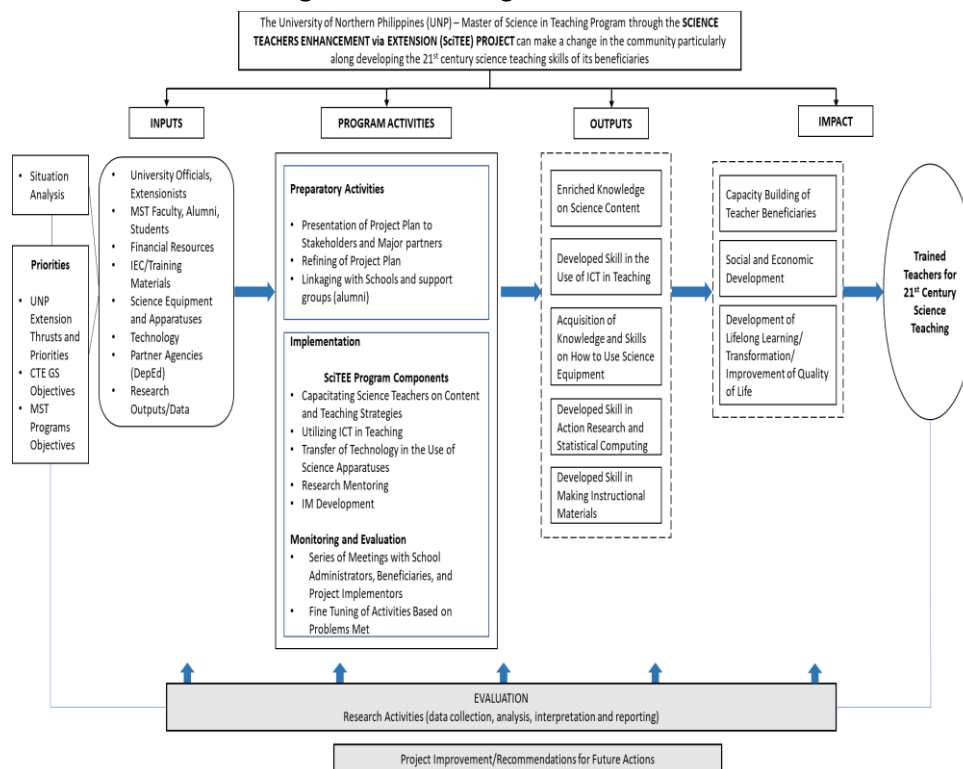


This model guided the conduct of the study. The model has six parts. The purpose or mission are the issues or possibilities that the Programs aim to solve. The context or conditions are the environments in which change will occur. The inputs are resources, infrastructure, raw materials, restrictions on the program, or obstacles to the objectives. The inputs are used to carry out the endeavor or initiative. The activities are interventions or initiatives that need to be made using its resources to provide the direction or change. The outputs are the results of carrying out the activities as intended. The effects are the outcomes, effects, or results. These alterations were a result of the activities, either directly or indirectly.

Conceptual Framework

The study is anchored on the model of change. The conceptual framework that directs the study is illustrated in the logic framework (please refer to Figure 2). The figure shows four main variables: input, programs and activities, output, and outcome.

Figure 2. SciTEE Logical Framework



In Figure 2, the resources required to start the Project, carry out its tasks, and achieve the expected outputs and outcomes are shown as the input variables. The Project's implementation processes, actions, and events are referred to as program activities. The results and products of putting the various tasks into practice are known as the outputs. The participants' knowledge, attitudes, and abilities have changed as a result of their involvement in the project, and these changes are the short- and long-term outcomes. The program's long-term benefits, sometimes known as the impacts, include things like the advancement of 21st-century science education and learning.

2. Methodology

The study used the mixed method of research, particularly the descriptive-evaluative mixed method of analysis. This method requires quantitative and qualitative data to answer the questions.

Population and Sample. The study's respondents were the participants of the different extension activities conducted under the SciTEE Project. Those who participated in the ICT, research mentoring, and IM Development assessed the outputs of the Project. However, only

the science teachers who participated in all the program components were part of determining the outcomes and impact of the Project.

The study used the triangulation method of data collection. This study required the use of a questionnaire. The study used the tool developed by till.org to measure the improvement in the ICT attitude and skills of the beneficiaries. The 21st-century teaching skills of science teachers were assessed using the instruments adopted from Ravitz (2014). The other data needed in the study were gathered using the method of interview and focus group discussion. This method was also used while monitoring the activities in gathering information as a basis for re-planning extension activities to make the SciTEE Project even more responsive to their needs.

For the data analysis method, the statistical program SPSS version 29 was used to perform the statistical analysis, particularly the frequency, and percentage, mean, and t-test of significant differences between means for dependent samples.

3. Results and Discussion

3.1. Extension Profile

In the SciTEE Project, many extension activities were conducted from 2016-2020. Table 1 shows a continuous implementation of training and seminars over the five years. The study implemented almost all the planned extension activities by year. The Project was sustained through the four (4) year period, which is a manifestation of the commitment of the administrators, faculty, students, alumni, and other stakeholders to attaining the Program's objectives and sustaining the Program.

Table 1. Number of Extension Activities Under the SciTEE Project
Serving Many Clienteles

Calendar Year	No. of Planned Activities	No. of Implemented Activities	Total number of beneficiaries	Average No. of Beneficiaries/ activity
2016	9	10	377	38
2017	5	6	362	60
2018	10	9	374	42
2019	4	4	191	48
2020	9	9	410	46

There were 37 planned activities from the different project components of the SciTEE Project and other preparatory activities from the year 2016 to 2020. There were 38 implemented, and one was unplanned. Due to its urgent need, this was implemented in 2016 and 2017. However, for the year 2018, one planned activity still needs to

be implemented due to unforeseen circumstances. There were many beneficiaries of the Project, with an average number of 47 participants per activity consisting of teachers and students.

3.2. Level of Implementation of the SciTEE Project

The SciTEE Project was assessed with a high level of implementation (mean=4.82). This result means that there was very high attainment of the objectives of the Project, which was done timely, the resources needed to implement the activity were very much adequate, and the activities were all attended. The very high level of implementation could manifest the participants' satisfaction with the various activities conducted to achieve the main goal of the SciTEE Project.

Table 2. Implementation of SciTEE Project Components

SciTEE Components	Mean	Level of Implementation
A. Capacitating Science Teachers on Content and Teaching Strategies	4.82	Very High
B. Utilizing ICT in Teaching Science	4.74	Very High
C. Transfer of Technology in the Use of Science Apparatus	4.85	Very High
D. Research Capacity Building	4.82	Very High
E. IM Development	4.86	Very High
Overall	4.82	Very High

The components of the Project were evaluated to have been highly implemented. For the project component that capacitated the science teachers on content and strategies, adequate training and seminar workshops provided the participants with opportunities to gain more knowledge on the different science content areas and correct some science misconceptions. These activities also taught them strategies to help overcome their students' fear of mathematical rigors in learning science.

The participants were also given enough opportunities to develop their skills in using ICT in teaching science. Some activities included making a teaching-learning package, using LoggerPro to produce visual presentations of abstract concepts, using a learning management system, and using educational learning management in mathematics.

Regarding the technology transfer, the participants were provided with training on how to design physics laboratory experiments, physics instrumentation and improvisation, and demonstration of existing physics laboratory apparatuses and equipment of the schools. Physics students' research outputs were also demonstrated to the participants as part of disseminating and utilizing these research outputs.

On research mentoring, the extension activities were on action research conceptualization, developing research proposals, data gathering tools, managing data, statistical computing, and writing research outputs in a publishable format.

Meanwhile, on the project component of IM Development, the participants were trained in developing science intervention materials. Likewise, they were also trained to develop modules that they can use in teaching science.

3.3. Evaluation of the SciTEE Project

The evaluation of the SciTEE Project was based on its outputs, outcomes, and impacts after its five years of implementation. The logical framework planned and designed for the Project guided the assessment.

Outputs of the Project

Based on the logic framework (Figure 2), the extension activities were expected to produce outputs on the part of the beneficiaries. These expected effects of the activities were adequately monitored and evaluated.

Enriched Knowledge of Selected Science Content. Six (6) extension activities were conducted to acquire additional knowledge and correct misconceptions in Physics and Chemistry. These include lectures and demonstrations of physics and chemistry, particularly on Thermodynamics, and teaching strategies that develop a better understanding of science concepts.

Before the varied extension activities, the teacher participants held 15 misconceptions about basic concepts in Heat and thermodynamics, which was understandable because not all teachers teaching Science subjects do not have science as their field or specialization. This is quite alarming because of the possibility of transferring these misconceptions to their students. But after exposing the participants to different lectures and activities that allowed them to concretize abstract concepts through demonstrations and experimentations, which corrected all their misconceptions of heat and heat transfer.

This is consistent with the conclusions of Bodner (2001) that aside from the fun it gives, demonstrations can provide concrete examples of abstract concepts and are a potential source of anomalous data that can trigger conceptual change. If demonstrations are appropriately planned and integrated effectively into learning concepts, it can develop a deep and rich understanding of science concepts, especially chemistry (Sweeder & Jeffery, 2013). Zimrot and Ashkenazi (2007) revealed how demonstrations could be practical. They must engage all participants in activities such as prediction and discussion.

In the experimentation method of teaching, Durmus and Bayraktar (2010) revealed in their study that the experimentation method is more successful than traditional instruction in overcoming misconceptions and acquiring permanent knowledge. This further supports the impact of the SciTEE Project and enriched knowledge on selected science content. Exposing the participants to lecture demonstrations and experimentations corrected their misconceptions on science concepts, particularly on heat and heat transfer.

Developed Attitude Towards and Skill in the Use of ICT. Table 3 shows the results of the teacher beneficiaries' change in ICT attitudes and skills after two years of being exposed to the ICT-based extension activities. The table shows that there is a significant change in the attitude ($t\text{-prob} < 0.05$) and skills ($t\text{-prob} < .05$) of the teacher beneficiaries before and after exposure to different extension activities through seminars and training regarding ICT. The findings are true regarding the beneficiaries' ICT attitudes and skills.

Table 3. Change in the Attitudes and Skills of SciTEE Project Beneficiaries Before and after Exposure to ICT-Related Extension Activities

Indicators	Before		After		t-ratio	t-prob
	Mean	Interpretation	Mean	Interpretation		
ICT Attitude	3.63	Positive	4.39	Extremely Positive	26.60	0.000
ICT Skills	3.21	Moderate	3.84	High	19.84	0.001

In the ICT attitude towards the use of ICT in teaching, the teacher beneficiaries changed their attitude that ICT is indeed necessary for students in doing more varied exercises as a way of mastering the tasks. In addition, their attitude that using ICT in teaching and learning impacts their students' motivation, achievement, and development of higher-order skills.

In the development of ICT skills among the teacher beneficiaries, they believed that they had improved significantly in their ability to produce a text using a word processing program, email a file to someone and internet surfing of varied fields of interests, make and administer online tests, create presentations with simple animations, and ability to create and maintain blogs or websites, as well as to participate in discussion forums.

Lectures on offline and online testing were discussed in the extension activities provided to the adopted schools. They were trained to make tests, whether offline or online, using the computer. In addition, they were trained to make video presentations, how to capture graphics,

as well as how to maximize the use of e-surfing. They were also taught how to capture graphics and make blogs. The teachers were also trained on the Learning Management System, where they were exposed to two online platforms.

Learning Management System or LMS is an important genre of ICT-driven education tools (Asamoah, 2020). It is a server-based software program containing details of users, course, and content, which provides a place to learn and teach without depending on time and space constraints (Bervell & Umar, 2017). And Jamieson-Proctor et al. (2013) stated that the use of ICT in education contributes a lot to effective learning. Additionally, Jorge et al. (2003) emphasized how ICT helps and supports both teachers and students, involving effective learning with the help of computers to serve the purpose of learning aids.

In the study of Finger and Trinidad (2002), it was revealed that for a learning process to be more fulfilling and meaningful, technology-based teaching and learning must be used for it offers various exciting ways, which include educational videos, stimulation, storage of data, the usage of databases, mind-mapping, guided discovery, brainstorming, music, and World Wide Web (www). In addition to audio, video, and text, communication tools (such as chat, discussion forums, email, and whiteboards) and evaluation systems can also help lecturers deliver course material.

Moreover, blogs, another ICT tool, are more successful in promoting interactivity that is conversational and more conducive to improving student and teacher relations, active learning, higher-order thinking, and greater flexibility in teaching and learning more generally (Ferdig & Trammel, 2004).

The skills the teacher beneficiaries develop in ICT are beneficial, especially during this time of NEW Normal Education, where teachers need to teach using the Learning Management System (LMS). The students also do distance education. The skills developed by the teachers in the training are expected to have been transferred to their students. Hence, the ICT component of the SciTEE Project is very essential to the skills needed for the New Normal Education.

Acquisition of Knowledge and Skills on How to Use Science Equipment. In the varied extension activities related to the use of science apparatuses and equipment like orientation and demonstration of existing physics laboratory apparatuses, Physics instrumentation, the teacher beneficiaries have acquired adequate knowledge about and the use of the different laboratory apparatuses that are kept in the school, but which are not being used by them because of the lack of knowledge and skills on how to use them. The schools have many

laboratory apparatuses which the DepEd gave. These are just placed in their stock room and still not opened; these are not yet unboxed.

According to Kwok (2015), laboratories are essential in science education. It plays a significant role in the active participation of students in their learning process (Council Science, 2019). Additionally, Tekin and Karamustafaoğlu (2012) stated that teachers should give more importance to laboratory work for students to acquire science concepts and avoid misconceptions correctly. Therefore, Duban and Yuksel (2019) concluded that "practical in-service training should be given to teachers from outside the field on the use of laboratories in science classes."

Being inspired by the knowledge and skills on how to use these apparatuses and considering the importance of demonstration in explaining abstract concepts to the students, the science teachers helped one another in bringing out the existing laboratory apparatuses in the school, prepared a room where these can be displayed in the school instead of just being placed in the stock room. They called this room their Science Laboratory Room. The MST Group assisted them in putting up this Laboratory Room. Those apparatuses reported to be non-functional were fixed by the MST Group. The science teachers and the students were happy having put up a Laboratory Room. The teacher beneficiaries also gained confidence in using these apparatuses in teaching. They did a demonstration as a strategy for contextualizing abstract concepts.

Developed skills in action research and statistical computing. From the knowledge acquired and the skills developed by the teacher beneficiaries during the training workshops on research mentoring and statistical data management and computing, the teachers have displayed skills in conducting action research and using the Statistical Package for the Social Sciences (SPSS). The teachers could conceptualize action research for possible implementation and submission at the DepEd for possible funding.

The conduct of action research was emphasized in the study of Hoover (2013), who contended that this type of research is different from other forms of research for it is more obstinate about changing teachers' or practitioners' practices to solve everyday problems in the school and classroom and aims at improving both student learning and teacher effectiveness.

Developed skills in making Instructional Materials. In the training workshops on the development of SIM, the teacher beneficiaries were taught the basic concepts and content of Strategic Intervention Materials. They were also shown varied examples along with science and tried doing it, and their outputs were critiqued by the participants who have been winners in the making of SIM.

The availability of sufficient and strategically designed IMs could lead to the productive teaching of science, especially in Chemistry (Salviejo, 2014). Moreover, Dahar (2011) stated that using IMs has a strong relationship with academic performance in secondary students. Also, the Department of Education employed one of the solutions in enhancing the academic achievements of students with low performance in science and technology – the DepEd Memo No. 117, series of 2005, training-workshop on Strategic Intervention Materials (SIMs) prepared secondary science teachers preparing SIM. Therefore, the conducted extension programs on developing SIMs were helpful to the participants and learners.

Reduced Anxiety in Mathematics. A training workshop on strategies to overcome fear in mathematics was then conducted. This allowed the teacher beneficiaries to learn teaching strategies that will make learning the computational aspect of science just for fun. After several months of using the teaching strategies learned, the anxiety level of the students was again determined using the same instrument. The student's anxiety level was reduced to average (Mean = 3.20).

Game-based teaching and learning mathematics was supported by the study of Inal and Cagiltay (2007) that the potential of games in fostering children's ability to communicate and interact and a practical science education tool in increasing adolescents' knowledge about science content presented in the game (Klisch et al., 2012). It was shown that their mathematics performance causes fear or anxiety (Namkung et al., 2019) and motivation, attitudes, and interest, stimulating positive academic emotions, accurately detecting students' emotions, and reacting to them appropriately are of crucial importance in educational settings (Bertram, 2020). However, playful learning, as called by Hirsh-Pasek et al. (2009), is a promising approach for effectively teaching students mathematics and computer science in an engaging, fun, and motivating way (Weisberg et al., 2016). Gamification of learning could provide students with possibilities for active, self-directed learning and have a beneficial impact on their attitudes, feelings, motivation, and engagement. Therefore, games are an effective way to overcome their fear and anxiety in mathematics.

3.3.2 Outcomes of the Project

The Science Teachers Enhancement via Extension (SciTEE) Project aims to help the educational system with the major changes needed in preparing teachers for 21st-century teaching. The SciTEE Project has contributed to the following:

Capacity Building of the Beneficiaries. The training on statistical computing using statistical Packages enabled the teachers to personally compute their own research data statistically. These skills enabled them to make their own research reports on their own. The

training workshop on Learning Management Systems (LMS) enabled the teachers to use the computer in developing a teaching and learning package.

The teachers gained competency in using the newly acquired apparatuses and equipment because of the knowledge and skills they acquired during the seminar on the orientation of science laboratory apparatuses and equipment. They became more competent and confident in using these science apparatuses for more effective and meaningful teaching and learning. During the Research Utilization Seminar, they gained additional knowledge and became more innovative in constructing improvised apparatuses using locally available resources. This means that technology transfer was successful. Meanwhile, the training on using Logger Pro in teaching enabled them to confidently explain abstract concepts like the actual behavior of a physical system.

Social and Economic Development of Beneficiaries. Inspired by the competencies and confidence developed among the science teachers in using laboratory apparatuses and equipment, coupled with the technical assistance provided in making the school-owned science apparatuses and equipment functional, the school could put up its science laboratory room. The science laboratory apparatuses have long been kept in the school because of a lack of knowledge of their use. Said apparatuses have long been not functional in the school. Because of the technical assistance provided by the MST group, the school does not have to hire a technician to make their apparatus functional or buy new apparatus because the teachers have developed skills in making science-improvised apparatus using locally available materials. The school does not have to buy or make laboratory manuals because the teachers were provided with a pamphlet containing basic laboratory activities for use by their students, as demonstrated during the extension activities.

The knowledge and skills developed by the teachers during the ICT training, particularly the use of computer-based evaluation materials, were transferred to their students. The students can already use computer-based or paperless testing. This skill is helping students nowadays in coping with the difficulties of learning brought about by the Covid-19 pandemic. The additional knowledge gained in using ICT increases the teachers' communication with their fellow teachers and students through the net.

With the skills developed by the teachers in statistical software, they claimed that they need not hire a statistician anymore or bring their data to a computer shop to manage their data, which they usually do, thus saving money and increasing their earnings. When shared with their colleagues, this skill also develops better social relationships. The

statistical skills developed by the teachers enabled them to make their research reports, creating a feeling of satisfaction and fulfillment.

The training workshop on Physics Olympics gave the teachers ideas and enabled them to try strategies to make the teaching of Physics fun. The students enjoyed and had fun learning Physics. It developed their knowledge of the subject and increased their interest in learning Physics. The competition developed their dealings with their fellow students.

Development of Lifelong Learning Skills and Improvement of Quality of Life. The teachers became capable of using a learning management system, the Edmodo. The use of Edmodo was a part of the training of the teachers under the SciTEE Project. The use of Edmodo in teaching makes teaching and learning possible anytime and anywhere. The teachers can just post the learning material on the platform for the students to access and learn. The students can also send their assignments and projects through the platform anytime and anywhere. This makes teaching and learning more accessible and more enjoyable. The students can also learn at their own pace.

The use of IT in teaching, especially the LoggerPro, makes the life of the science teachers a lot easier because they no longer do the necessary computations because LoggerPro gives the exact location, speed, and other parameters that characterize the behavior of a physical system. They don't necessarily have to make a graph showing the location of the physical system/body because the LoggerPro can give it automatically. Hence, the teachers can focus on explaining the concept behind the behavior of the system. On the part of the students, they will develop lifelong learning skills because they can see the behavior. Abstract teaching is transformed into real teaching, and abstract understanding is transformed into real understanding.

3.3.3 Impact of the Project on the Development of Teachers for 21st-century science teaching and Learning

The main goal of the SciTEE Project is to prepare the science teacher beneficiaries for 21st-century teaching. With the support of the UNP administration, the partner agencies, extensionists, and the MST Physics could do their role in preparing the science teachers for 21st-century teaching.

Based on the conceptual framework, 3 themes of skills are needed: Learning and Innovation Skills, Life and Career Skills, and Information, Media and Technology Skills, and Making Global and Local Connection Skills.

Learning and Innovation skills cover the following: Critical thinking, Collaboration, Communication, and Creativity and Innovation skills. Meanwhile, life and career skills include flexibility, adaptability, initiative, and self-direction.

After five years of being exposed to training, seminars, workshops, and demonstrations through the SciTEE Project, there was a change in how they teach science, from less active to more active practice, giving more opportunities for their students to maximize their skills and potential. The teacher beneficiaries were found to have developed higher skills needed for 21st-century learning, from average to high level. There was improvement of almost all the 21st century skills of the teachers from average to high except in making global connections and ICT skills, which even improved from low to high level of skills.

The teacher beneficiaries demonstrated a high level of critical thinking abilities, demonstrating that they are now prepared to provide their students with sufficient opportunities to develop their abilities to analyze complex problems, research open-ended questions, evaluate various points of view or potential sources of information, and draw appropriate conclusions based on evidence and reasoning.

As to providing their students with learning opportunities to develop their collaboration skills, the teachers have developed a high skill level (from an average level). Giving students time to collaborate on problems or questions, work efficiently and politely in teams to achieve a goal, and take on shared responsibility for finishing a task are all practices they have developed.

The teachers also have developed a high level of communication skills (from an average level). The teachers asserted that they have been given their pupils enough time to arrange their ideas, information, and conclusions and to successfully communicate these using a variety of media, as well as orally and in writing.

About creativity and innovation skills, there was also an improvement from average to a high level. The teachers divulged that they now require their students to do brainstorming sessions or concept-mapping activities. They also give them work to enable them to generate and refine solutions to complex problems or tasks based on synthesis, analysis, and then combining or presenting what they have learned in new and original ways.

On self-direction, the high level of skills of the teacher beneficiaries (from average) implies that they have changed their practice of letting their students take responsibility for their learning. When the teachers were asked how often they asked their students to take the initiative when confronted with a complex problem or question and plan the steps they will take to accomplish a task, they responded, "three times a week." They also claimed to have practiced letting their students monitor their progress towards completing a complex task and using peer, teacher, or expert feedback to revise their work.

On the development of global connections, giving pupils opportunity to enhance their grasp of global, geopolitical issues, including

awareness of geography, culture, language, history, and literature from various countries, is a practice created by the teaching beneficiaries. According to the teachers, they advise their students to research science-related facts about other nations and consider how their personal experiences and local problems link to global problems.

The development of making local connections among the teachers, a high level (from average) was found. This means that they have cultivated the habit of making their students capable of applying what they have learnt to local contexts and community challenges. They disclosed that they now routinely demand that their pupils conduct research on subjects or problems that are important to their family or community and then apply what they have learned to specific local challenges or circumstances.

The last skill that was developed among the teacher beneficiaries is the use of technology as a tool for learning. The teachers asserted that they have developed the habit of providing their students with sufficient possibilities to direct their own learning and create goods utilizing suitable information and communication technology. They are now allowing their pupils to use technology or the internet for self-instruction using resources like PHET, Khan Academy, or other films, tutorials, self-instructional websites, etc. The professors concur that they have begun to help the students hone their technology-related learning skills.

A significant improvement in the 21st Century Skills of the Teacher Beneficiaries was also noted. Results of the t-test revealed a significant change in all the critical thinking skills after being exposed to the different seminars, trainings, workshops, and demonstrations. Therefore, the SciTEE Project has prepared the teachers with the demands of 21st-century learning, whose aim is to develop students to become productive and contributing members of the workplace.

Since the development of 21st-century skills is not only a concern at the local level or the national level but at the global level, the university, through the SciTEE Project, has contributed a significant role in attaining the global goal of providing our student's life experiences that can carry over to their day-to-day adult lives.

Conclusions and Recommendation

Based on the theory of change model, the SciTEE Project has contributed to the global goal of preparing teachers for 21st-century learning. It has equipped science teachers with additional knowledge, even for those who are not majoring in the field and developed the program beneficiaries' competencies in teaching science (Physics and Chemistry). Through their participation in the Project, they have

gained social and economic benefits and have transformed them into better and more effective teachers.

It is recommended, therefore, that the University should sustain the SciTEE Project and elevate further the competencies of its beneficiaries. The Project may be extended to other teachers in other schools. The methodology used in the study may also be replicated in other curricular programs in other universities.

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