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Strategic impact assessment of revitalized science, technology and engineering program

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Abstract

The study was conducted to evaluate the revitalized implementation of the Science, Technology and Engineering (STE) program through strategic impact evaluation. Using a descriptive-evaluative design, purposive sampling technique was also employed to identify the 119 former STE students and 17 STE science teachers from selected public Junior High School in the Philippines. A set of adapted tests were used in the gathering of data and questionnaires for the implementation of the STE Program. The results revealed no significant relationship between the learners' profile and the implementation of the STE program as well as no significant relationship between science skills and program implementation except for observing skills. However, there is a positive relationship between students' attitudes towards science subjects to STE program implementation. This study holds true that the STE program in the Philippines has a long way through its development. However, it given high hopes through the positive perception of the students and teachers in the program. While there are other factors to be considered in the evaluation of the program, this study has given fundamental inputs to program development through triangulation with teachers, students and experts.

Keywords: *STE program, science skills, students attitudes in science, students interest in science, crafted guidelines*

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1. Introduction

The global importance of science and technology which dominates every society requires an educational system that provides a venue for the development of scientific knowledge and skills. The rapid development of this field of knowledge through scientific inventions and discoveries poses a challenge to educational institutions to contribute their part in this growing demand for scientific inquiry. In the Philippines, the Department of Education (DepEd) commits itself to the development of the full potential of students in all areas. One of its thrusts is to produce quality learners in the field of science and technology. Through the Special Curricular Program (SCP), the Science, Technology, and Engineering (STE) Program is envisioned that DepEd will produce highly responsible, morally upright, globally competitive, and work-ready learners imbued with desirable values and equipped with 21st-century skills that can contribute to nation building and national transformation while preserving Filipino culture, heritage, and identity (DepEd Memorandum No. 129, s. 2014). The learners of this program are provided with opportunities through an enhanced science-technology-oriented curriculum that will prepare them for higher education in work with a strong focus on science, technology, mathematics, and research (Rafanan et al., 2020; Kennedy & Odell, 2014).

Despite the government's investment in several initiatives aimed at improving education quality, particularly in the fields of science, technology, and engineering, assessment seem too limited (Kayan-Fadlelmula et al., 2022; Aslam et al., 2022; Li et al., 2020; Pierszalowski et al., 2021; Zhan & Niu, 2023). While most studies already pinpointed some alarming challenges of STEM program in the Philippines (Rogayan et al., 2021; Sison, 2022) and various parts of the world (Bardoe et al., 2023; Ejiwale, 2013; Harris & Hodges, 2018; Lee et al., 2019; Al Murshidi, 2019; Hsu & Fang, 2019; Carter, 2020), there are limited studies on the practices and strategies in sustaining the program. There are several studies highlighting the need for student intervention (Kennedy & Odell, 2014; Bertrand & Namukasa, 2020; Stehle & Peters-Burton, 2019; Darling-Hammond et al., 2020; Harackiewicz et al., 2016; Leung, 2023; Kelley & Knowles, 2016; Sáinz et al., 2022; Akcan et al., 2023) however there has been persisting challenges not addressed (Sithole et al., 2017; Ahmed, 2016).

According to Padwick et al. (2023), evaluating the effectiveness of STE program interventions requires process evaluation more than quantitative evaluation. A process evaluation concerns with how a program outcome or impact was achieved, such as a tracer study or impact evaluation. While tracer study is mostly concerned with the graduates' employability (Kula-semos et al., 2020), it also provides essential data to inform program improvements (Chima et al., 2023) while impact evaluation assesses the long-term effect of the program. Hence, in the case of STE program, a strategic impact evaluation is necessary to evaluate both the outcome and its impact. There are several studies that evaluated the STE program in the Philippines (Macaranas & Robles, 2023; Sarmiento et al., 2020; Morados, 2020; Torreña, 2020; Andrada & Marasigan, 2020) and tracer studies of STE undergraduate programs (Dotong et al., 2016; Reusia et al., 2020; Ramirez et al., 204) but there is limited tracer study on High School STE program (i.e. Domanais & Quiapon, 2022) due to the late implementation of the K to 12 programs and no studies on strategic impact evaluation of STE program. Hence, this study sees the need to conduct a strategic impact evaluation for the implementation and enhancement of the program itself.

2. Literature Review

2.1. Teaching and learning in STE program

The STE program, one of the Special Curricular Programs offered by the DepEd, provides learners with an enriched, science and technology-oriented curriculum that prepares them for higher education or work in the fields of science, technology, and engineering (DepED Order no. 021, s. 2019). Since the development of science skills has become an important component of science curricula at all levels, the implementation of the scientific technology and engineering program is given special attention. According to Almeyda (2010), precondition knowledge, concepts, and principles can be gained only if the students have certain underlying capabilities. This procedural competence in developing scientific skills is influenced by the scientific basic skills that are needed to practice and understand science. However, learning depends on many factors. For instance, a highly motivated student has a positive attitude toward the subject he is learning (Bureau et al., 2022), hence, teachers should engage students (Hornstra et al., 2015). Similarly, the learning environment inspires not just students who want to go to school but also those who want to study and participate in their studies (Movahedzadeh, 2011 as cited by Maranan, 2017).

In the modern day learning, studies have also shown that the use of technology produces a positive impact on students (Haddock et al., 2022; Ramírez et al., 2021; Francis, 2017; Schindler et al., 2017), in addition to individual factors and forces which play an important role in science teaching. For instance, Joaquin and Andal (2023) suggest flipped program because it has positive effect on students' performance while Leo and Puzio (2016) found that students preferred to watch video lectures away from class and appreciated more active teaching methods. In addition, students become more interested in the learning process when taught science subjects with technology, helping them to complete tasks easier than if they were taught traditional methods (Nawzad et al., 2018).

The role of teachers in learning science has been emphasized in several studies. According to Todd (2020), 50% of the surveyed students said that their teacher affects the level of their interest in science. The interpersonal connection between the teacher and students play a pivotal role in improving the level of students' positive attitudes toward science subjects. For this, dela Rama (2020) asserts the importance of training on teaching and learning such as seminars, and capacity building on subjects related to effective science teaching, conversion of instruction material into an electronic format and familiarity with different functions and features of eLearning platforms. On the other hand, Maffea (2020) cited the lack of appropriate material that not only affects teaching but also gives rise to motivation for teachers to deal with lessons.

2.2. Challenges in the management of STE program

The study of Maranan (2017) disclosed lack of scientific culture and weaknesses in school curricula, instructional materials, learning curriculum, and teaching practice as the major factors leading to low science performance of Filipino students. While the tracer study of Morados (2020) found STE graduates substantially performed better than those who are non-STEs, the Philippines is still lagging in three different global evaluations that scored students' performance in science, technology, engineering and mathematics (Sison, 2022). The increase employability can be attributable to the increased resources at their disposal, as well as adding more science and math subjects into the curricula, alongside a relatively high level of intellectual abilities among STE students. However, several studies had disclosed reasons for poor performance of STEM programs in the country such as teachers' qualifications (Tupas & Matsuura, 2019; Gamboa et al., 2020; Diate & Mordeno, 2021),

curriculum (Tupas & Matsuura, 2019; Almazan et al., 2020; Diate & Mordeno, 2021), school facilities (Tupas & Matsuura, 2019; Abas & Marasigan, 2020; Pacala & Cabrales, 2023), teaching and learning (Tupas & Matsuura, 2019; Sadera et al., 2020; Pacala & Cabrales, 2023), learning resources (Tupas & Matsuura, 2019; Gamboa et al., 2020; Sadera et al., 2020) and laboratory facilities for practical learning (Tupas & Matsuura, 2019; Abas & Marasigan, 2020; Pacala & Cabrales, 2023; Diate & Mordeno, 2021). These common problems in the country are similar to the studies in various countries facing the same issue on low STEM performance (Kamba et al., 2019; Abidoye et al., 2022; Assem et al., 2023; Chand et al., 2021; Han et al., 2021; Makgato, 2007; Banerjee, 2016).

3. Methodology

This study is descriptive research with survey as data gathering technique. It used the strategic impact evaluation, which the OECD defines as an assessment of how the intervention being evaluated affects outcomes. According to Rogers (2014), impact evaluation can be undertaken of a program or a policy. The usual evaluation criteria involve relevance, effectiveness, efficiency, impact and sustainability. In this study, these criteria evaluated the school resources, academic program, delivery of instructions, program management and monitoring and evaluation.

The 119 students and the 17 science STE program teachers were chosen through purposive sampling. The student must be enrolled Grade 11 STE program while the teacher must be stationed in any school within third cluster of Laguna Division that offers STE Program and handing science subjects under the STE program. Validators were also chosen based on their educational backgrounds and experience as school administrators and science instructors from different schools inside the Division of Laguna.

Table 1 summarizes the demographic characteristics of the participating students. The research variables include the final grade (μ=92.14; σ=2.3), attitude towards STE program (μ=3.63; σ=0.41), and the various scientific skills such as classifying (μ=4; σ=1.43), inferring (μ=7.4; σ=2.69), observing (μ=4; σ=1.8), making hypothesis (μ=4.5; σ=1.71), interpreting data (μ=5.4; σ=2.34), defining (μ=2.6; σ=1.18) and measuring (μ=3.1; σ=1.45). The final grades of the students range from 85 to 97, the attitude towards STE program ranges from 2.70 to 4.58 weighted means and the scientific skills range from 0 to 12.

Table 1

Demographic characteristics

Characteristic	Highest	Lowest	Mean	Standard Deviation
Final grade	97	85	92.14	2.3
Attitude towards the STE Program	4.58	2.70	3.63	0.41
Classifying skill	7	0	4	1.43
Inferring skill	12	0	7.4	2.69
Observing skill	7	0	4	1.80
Making hypothesis skill	9	1	4.5	1.71
Interpreting data skill	11	1	5.4	2.34
Defining skill	5	0	2.6	1.18
Measuring skill	6	0	3.1	1.45

The study used a test lifted from the Science Learner's manual for Grade 10 recommended by the DepEd and a questionnaire available in the contextualized manual for the implementation of the special curriculum programs in science by DepEd Caraga. In addition, the evaluation of the crafted guidelines used the Basic Education Monitoring and Evaluation Framework according to DepED Order no. 29, s. 2022. For the evaluation of the science, technology, and engineering program in terms of its domain, an evaluation 46 sheet was adapted from the Regional Contextualized Manual for the Implementation of Special Curricular Programs in Science by the DepEd Caraga version 1.0 and was released on October 2021.

The test was administered to the number of respondents present and currently enrolled at the four (4) selected senior high schools within the third cluster district of the Division of Laguna. The testing administration rules were strictly followed and the time allotment was enforced to ensure standard procedures in the test administration. Meanwhile, the survey for the science teachers and coordinators was conducted by the researcher.

The statistical methods used were frequency distribution and Pearson correlation. Kendall's Tau was also used in this study to understand the existing relationship between two variables such as the implementation of the STE program to the development of the scientific skills among the STE students. Pearson r analysis was used for the description of the

relationship existing between the scientific skills of the students and the level of implementation of the STE program and the relationship between the revitalized guidelines on the implementation of the STE program with its perceived intermediate outcomes.

4. Findings and Discussion

Table 1

Comparative evaluation of the STE program by students and teachers

Parameters	Students			Teachers		
	Mean	**SD**	**VI**	**Mean**	**SD**	**VI**
1. School resources	3.58	0.33	HO	3.47	0.49	HO
2. Academic program	3.75	0.82	HO	3.62	0.49	HO
3. Delivery of instructions	3.75	0.82	HO	3.58	0.38	HO
4. Program management	3.81	0.72	HO	3.52	0.38	HO
5. Monitoring and evaluation	3.82	0.76	HO	3.34	0.43	HO
Overall	**3.74**	**0.086**	**HO**	**3.51**	**0.11**	**HO**

Legend:	**Range**	**Remarks**	**Verbal Interpretation**
	3.50-4.00	Strongly Agree	Highly Observed (HO)
	2.50-3.49	Agree	Observed (O)
	1.50-2.49	Disagree	Slightly Observed (SO)
	1.00-1.49	Strongly Disagree	Not Observed (NO)

Table 1 shows the comparative evaluation by the students and the teachers. The overall assessment of the students generated a mean of 3.74, which is highly observed. This indicates that the implementation of the different programs among the different schools is properly implemented as perceived by the former STE students. The standard deviation values further show that the respondents have almost the same perception that concretizes the study.

Based on the assessment of the students, the schools are seen as excellent implementors of the STE program. The practices on the implementation of the program coincide with previous studies emphasizing the establishment and provision of relevant instructional materials and teaching methods and techniques (Asabiaka, 2018), resource policies (Hanushek, 2014), appropriate learning environment (Tori & Kallery, 2021), effective teaching and learning process (Yusuf & Dada, 2016), professional development for

teachers (Adeyemi, 2016), institutional support (Palines & Dela Cruz, 2021) and program monitoring and evaluation (Vaccaro & Sabella, 2018). Similarly, the science teachers rated the academic program with a mean of 3.62 as the highest while the monitoring of the STE program got only 3.34 that makes it the lowest among the given variables. Based on the result, science teachers agreed that the academic program on the implementation of the STE program supports the development of the students' interest and successful transfer of knowledge to the students based on the verbal interpretation where all of its indicators got a highly implemented level. When it comes to good practice in the curriculum, most of the STE implementers are focused although inclusion of at least two elective science subjects is missing explaining the mismatch between the level of perception of students and teachers in the implementation of STE program. Meanwhile, the monitoring by the regional and division levels and the allocation of the budget for the implementation of the program got the lowest rating because some offices failed to monitor the development of the program and failed to allocate enough budget for proper and effective implementation. The grading system got the highest mean of 3.88 and 0.33 standard deviation because it follows the DepEd Order no. 8, s. 2015 and DepEd Order no. 31, s. 2020. However, the retention of the students in the program becomes a challenge for some teachers as students find it hard to maintain the 88% average rating; hence, they lower the rating to 85%. The results of the assessment highlights the previous recommendations on institutional support for teachers (Manalo & Chua, 2020), effective implementation of teaching strategies (Formalejo & Ramirez, 2017), and sufficient laboratory and learning resources (Palines & Dela Cruz, 2021).

Since the experiences of students are far different than the roles and responsibilities of the STE teachers, the ratings of the two sets of participants are totally different. Several studies identified differences in the perception of teachers and students in the teaching and learning environment of STE program. Fitzgerald et al. (2020), comparing the difference betwee 86 teachers and 2512 grade 9 and 10 students in the United Kingdom, reported teachers' constant overrating of their teaching practices. In Indonesia, while the teachers show the same level of assessment of STEM education, teaching methodologies were not appropriate to the preferences of the students leading to weak achievement in the program (Permanasari et al., 2021). The current findings contrast with the study of Ben-Chaim and Zoller (2001) emphasizing the good correspondence of teaching styles and STEM students'

learning preferences in Israel and Saptarani et al. (2018) that students and teachers in Indonesia consider STEM essential for future career development. In terms of geographical location, He et al. (2022) found differences in the perception of Chinese and UK students on STEM program, with Chinese students consistent higher ratings of STEM education than UK students.

This study supports previous findings that students best learned when they are exposed to the learning process and have the opportunity to experience the learning through practical application and work placement. These are the same findings of Fairhurst et al. (2023), Roberts et al. (2018), Su et al. (2022) and Meng et al. (2014). The availability of learning materials greatly aide the learning process. Meanwhile, teachers' program monitoring adds significant ideas for its development. While previous studies pointed out the importance of the STEM learning environment (Margot & Kettler, 2019; Chaya, 2023; Thi To Khuyen et al., 2020; Wang et al., 2011; Pathoni et al., 2022; Sobri et al., 2021; Sellami et al., 2022; Kamizi & Iksan, 2021; Kinkopf & Dack, 2023; Akiri et al., 2021) in the continuous program development, the current study asserts the benefits of program monitoring as a good practice for the better impelementation of the STE Program.

Table 2

Acceptability of the revitalized STE program guidelines

	Students			Experts		
Parameters	**Mean**	**SD**	**VI**	**Mean**	**SD**	**VI**
1. Access	2.14	1	A	2.33	0.76	A
2. Equity	2.08	0.74	A	2.22	0.71	A
3. Quality	2.44	0.43	HA	2.78	0.43	HA
4. Resiliency and Well-Being	2.58	0.45	HA	2.81	0.44	HA
Overall	**2.31**	**0.24**	**A**	**2.54**	**0.30**	**HA**

Legend :	***Range***	***Remarks***	***Verbal Interpretation***
	2.34 – 3.00	*Highly Evident*	*Highly Acceptable (HA)*
	1.67 – 2.33	*Evident*	*Acceptable (A)*
	1.00 – 1.66	*Not Evident*	*Not Acceptable (NA)*

Table 2 shows the level of acceptability of the revitalized STE program guidelines. In terms of the acceptability measured by both students and teachers, the equity, or the fairness of the program to be offered to everyone got the lowest mean among the given variables. It has the lowest mean of 2.08 for the students and 2.22 for the evaluation of teachers. On the

other hand, resiliency and well-being got the highest mean of 2.58 for the students and 2.81 for the STE science teachers evaluation. The results imply that students have the opportunity to access quality education that could help them in their career and future development. These are similar to the study of Llego (2022) on the inclusivity in the field of education in the Philippines through the ALS providing non-traditional learning opportunities for students. The results are also explained by the study of Choi et al. (2023) on the concept of resilience. Since Filipino students are known to be resilient, they tend to adjust to their school environment. They recognize the flaws of the program implementation but tend to look at the brighter side of the program.

The evaluation of the expert validators shows that the revitalized STE program as to its intermediate outcomes in terms of access and equity is under the acceptable level while the quality and the resiliency and well-being has a highly acceptable level. The results highlight the similar findings of Kart and Kart (2021) on inclusive education and Mamba et al. (2021) on the value of ALS.

Table 3

Test of relationship between students' profile and STE program evaluation

Learner's Profile	*Implementation of the STE Program*			
	Academic Program	Delivery of Instruction	Program Management	Monitoring and Evaluation
Final Grade	-.036	-.079	-.018	-.004
Students' Attitude	.356**	.297**	.231*	.239**
Scientific Skills				
Classifying	-.042	-.043	-.038	-.077
Inferring	-.029	.061	-.023	-.058
Observing	-.182*	-.143	-.219*	-.181*
Making Hypothesis	-.062	-.008	-.046	-.138
Interpreting Data	-.087	-.111	-.079	-.133
Defining	-.156	-.078	-.127	-.157
Measuring	-.035	-.055	-.075	-.056

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

The test of correlation in table 3 shows that the final grades of the STE students are not significantly correlated to the academic program with 0.36 r-value, delivery of instructions r-value of 0.79, program management r-value of 0.18, and monitoring and

evaluation with an R-value of 0.004. Meanwhile, students' attitudes towards the program is significantly correlated to the academic program (r-value=.356), delivery of instructions (r-value=.297), program management (r-value=0.231) and monitoring and evaluation (r-value=.239). However, most of the science skills such as classifying, inferring, making a hypothesis, interpreting data, defining, and measuring are not significantly correlated with the implementation of the STE program. Since most of the students obtained a beginner level in the science skills test, it does not provide empirical evidence of relationship with the program implementation parameters. The only skill with positive correlation to the componenets of the program implementation (academic program, program management and monitoring and evaluation) is observing. Since the student-respondents were former STE students from school year 2021-2022, before the implementation of the online and modular modality of learning, they experienced face-to-face learning during their grades 7 and 8. This probably explains the moderately positive attitude towards science. Furthermore, they were acepted into the program with the required outstanding grades in science, math, and English subject.

5. Conclusion

With the assessed revitalized STE program and program guidelines, this study found no significant relationship between the learners' profile and the implementation of the STE program. Similarly, there was no significant relationship between science skills and program implementation except for observing skills. However, there is a positive relationship between the students' attitudes towards science subjects to STE program implementation.

This study holds true that the STE program in the Philippines has a long way through its development. However, it given high hopes through the positive perception of the students and teachers in the program. While there are other factors to be considered in the evaluation of the program, this study has given fundamental inputs to program development through triangulation with teachers, students and experts. The continuous monitoring and evaluation of the program is vital to the performance of the students and the program itself. Hence, this study recommends closer look on the institutional support on the STE program, quality assurance of the program and the tracing of the graduates.

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