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**STEM TEACHERS' DISPOSITION TOWARD REFLECTIVE PRACTICE
TRAINING PROGRAMME AND ITS EFFECT ON THEIR PROFESSIONAL
DEVELOPMENT**

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Abstract

As Science, Technology, Engineering and Mathematics (STEM) fields continue to progress rapidly, the demand for effective STEM educators has never been greater. To ensure the growth and success of STEM education, investing in the professional development of STEM teachers is essential. Reflective practice has emerged as a promising approach to enhance the skills and expertise of STEM educators by encouraging self-assessment, critical thinking, and continuous improvement. This study focuses on the disposition of STEM Teachers to professional development training programmes on reflective practice and its impact on teaching. The study employed a pretest-posttest quasi-experimental design with 102 STEM teachers purposively selected from 52 schools in Oyo State. Data collected using two instruments were analyzed using simple percentages, means, standard deviations, and a paired samples t-test. Results show that STEM teachers have a positive disposition toward reflective practice, and the training significantly enhances their professional growth. Recommendations were made that all stakeholders should establish a supportive administrative framework that encourages and facilitates reflective practice as a form of professional development programme for STEM teachers.

Keywords: STEM teachers, Reflective practice, Professional development, Disposition, classroom engagement

Introduction

In the era marked by innovative and technological advancements, the role of Science, Technology, Engineering, and Mathematics (STEM) teachers is more critical and demanding than ever. They must not only be an expert but also a reflective practitioner. In this era of technological advancement and innovation, teachers need to be highly knowledgeable and up to date. Many teachers teach behind closed doors in isolation from their colleagues, and according to Eisner (1998), professional isolation leads to professional ignorance. Professional development (PD) refers to on-the-job training activities ranging from formal, lecture-style training to mentoring and coaching (Anna, David, Mary, & Violeta, 2022). PD is a training given to in-service teachers by an expert in the profession that can be individualized or in groups. Professional development can make teachers more resilient and able to cope with the challenges of the teaching profession (Mansfield & Gu, 2019). Features of such PD according to Darling-Hammond (2017) includes: being content focused, incorporates active learning, utilizing adult learning theory, supports collaboration, typically in job-embedded contexts, uses models and modeling of effective practice, provides coaching and expert support, offers opportunities for feedback and reflection, and should be of sustained duration. An example of approaches to professional development is Reflective Practice.

Reflective practice is the practice of colleagues in service joining together to watch over one another for improvement in their teaching career, guiding the students through their learning process, and nurturing students' interest and confidence. It means looking at what is done in the classroom, thinking about why it is done, how it is done, and thinking about whether it works or not (Agoro, 2013). It is a process of self-observation and self-evaluation. Reflective Practice is usually considered a form of cyclical and systematic inquiry where teachers carefully collect evidence about their teaching practice to analyse, interpret, and evaluate their teaching experiences to improve their future teaching (Mathew & Peechattu, 2017). It involves mentoring an individual to develop professionally through senior colleagues. There is a long-standing recognition in the field of science education that teachers must continuously reshape their knowledge of teaching and learning. Reflective Practice occurs when teachers consciously take on the role of the reflective practitioner, subject their

own beliefs about teaching and learning to critical analysis, take full responsibility for their actions in the classroom, and continue to improve their teaching practices. These beliefs provide a basis for researching reflective practice and suggest a way science teachers can incorporate reflective practice into their teaching as a means of professional development in this era of aggressive and mandatory reform in our nation's educational sector. Methods of reflection include the following: reflective journal, videotaped lesson/peer conference, students' input and lesson evaluations, and students can provide a structural evaluation of a lesson (Risko and Vogt, 2016)

This study was based on Kolb's Reflective model, which highlights the concept of experiential learning and is centered on the transformation of information into knowledge. This takes place after the situation has occurred and entails a practitioner reflecting on the experience, gaining a general understanding of the concepts encountered during the experience, and then testing this general understanding in a new situation. In this way, the knowledge that is gained from a situation is continuously applied and reapplied to build on a practitioner's prior experience and knowledge (Kolb and Kolb, 2005).

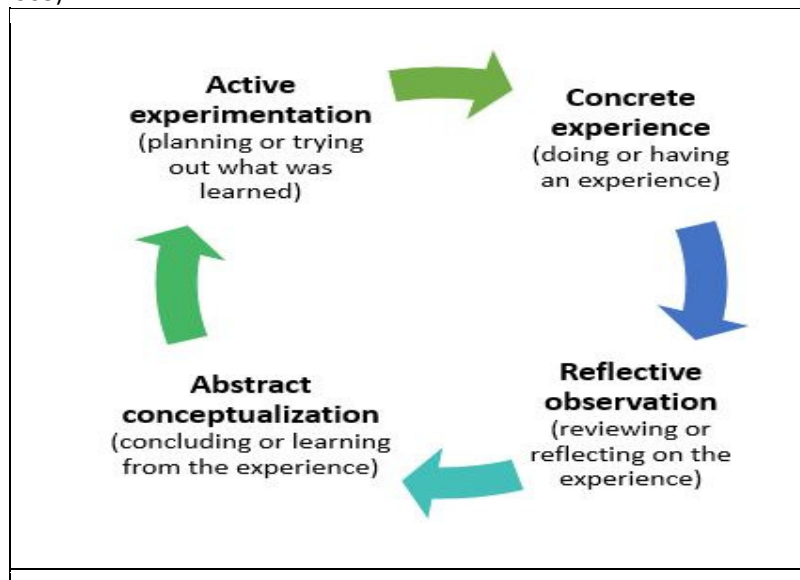


Figure 1. *The Experiential Learning Cycle*

This figure illustrates the experiential theory of learning as a cycle of concrete experience, reflective observation, abstract conceptualization, and active experimentation. (Kolb, 2014). In Kolb's framework for reflection, the concrete experience refers to the teaching situation at the moment the teacher is focusing on and noticing in terms of her teaching, the students, and the learning process. The Observation and Reflection stage refers to the ability to think back to a teaching situation and describe in detail what happened during the lesson. At this stage, the teacher tries to answer the question, "What happened"? In the abstract or conceptualization stage, a teacher tries to understand what happened in the classroom and investigates the reasons for it. At this point, he/she tries to answer the question "Why did it happen"? Based on emotion, teaching experience, and personal and theoretical knowledge, in the final stage, Active Experimentation, the reflective practitioner decides on what her next step will be, given the information gathered in the description and analysis of the situation. "What will I do next? What will I do about this situation"? Is what the teacher plans. This cyclical step of Kolb's reflection applies to reflective practice and it's the one adapted in this study.

Reflective practice promotes collaboration among teachers, encouraging them to observe and critique each other's teaching. Reflective teachers aim to deepen their understanding of themselves and their teaching practices, leading to better solutions and improved educational outcomes (Samaranayake, Premadasa, Amarasinghe, & Paneru, 2018). Furthermore, reflective practice is crucial for addressing the challenges and complexities of teaching. It involves a deliberate and thoughtful examination of one's teaching practices, experiences, and beliefs to improve teaching effectiveness and student learning outcomes. Reflective teachers not only aim at gaining better solutions but also attempt to deepen their understanding of themselves and how the solutions they discover connect to other experiences and ideas (Ponsawan & Sumalee, 2021). Studies have shown that reflective practice facilitates learning through experiences, integrates classroom learning into practice, and helps both students and teachers identify learning needs (Ghanizadeh, 2017; Tsingos et al., 2014; Chan & Yeung, 2019).

Statement of the Problem

Reflective practice is a powerful tool for practitioners to develop self-awareness about the nature and impact of their performance on the teaching and learning process. It offers opportunities for professional growth and development by allowing practitioners to gain insights into their behavior and assume the dual role of actor and critic. Practitioners can use various methods such as reflective journals, peer conferences, and student feedback to facilitate this process. Nurturing and sustaining reflective practice require a commitment to continuous learning and improvement. Practitioners should engage in regular reflection, seek feedback from colleagues and students, and participate in professional development activities. Collaboration with peers and mentors can also provide valuable insights and support. However, despite its proven benefits in enhancing teaching quality and lifelong learning, many STEM teachers either underutilize reflective strategies or lack adequate exposure to structured reflective practice training programs. This study, therefore, aims to investigate the disposition of STEM teachers to become reflective practitioners, to improve their professional development, and enhance teaching effectiveness. It also explores the disposition of STEM teachers toward reflective practice training programmes and evaluates the impact of such programmes on their professional development. Through a rigorous review of literature and empirical data, the research highlights the transformative potential of reflective practice in STEM education.

Objectives of the Study

The study achieved the following objectives:

1. Determine whether STEM teachers in Oyo State exhibit a positive disposition toward reflective practice, providing insights into their overall attitude and openness to this professional development approach.
2. Investigate the effects of professional development training on STEM teachers' professional growth, examining whether the training leads to measurable improvements in their teaching practices and overall professional development.
3. Explore how practicing teachers define reflective practice and the methods they use to engage in it, aiming to understand their approaches and perspectives on this practice.

4. Analyze how practicing teachers use reflective practice to advance their professional development, including its impact on their teaching strategies and career growth.

Research Questions

The following research questions were answered during this study.

Research Question 1: What is the level of positive disposition of STEM teachers in Oyo State to reflective practice?

Research Question 2: To what extent does the training undergone by STEM teachers have effects on their professional development?

Research Question 3: How do practicing teachers define and engage in reflective practice?

Research Question 4: How do practicing teachers develop their profession by being reflective practitioners?

Methodology

The study employed a pretest-posttest quasi-experimental design. It focused on STEM teachers within the four Local Government Areas (Afijio, Atiba, Oyo East, and Oyo West) of Oyo metropolis, Oyo State. The population comprises all 54 public secondary schools across these Local Government areas. From each of these schools, two STEM teachers were purposively selected based on the following criteria: a minimum of ten years of teaching experience, current teaching of JS II and III classes, and no additional administrative duties. This selection process yields a sample size of 108 STEM teachers. Additionally, the study involved 8 facilitators and 4 supervisors (who were lecturers from the faculty of Science Education at Emmanuel Alayande University of Education, Oyo), with one training center established in each local government area to facilitate easy access for all participants. Two key instruments were developed, validated, and employed to gather data for this study. They are:

1. Reflective Practice for In-Service STEM Teacher Operational Guide:

It is a training guide on reflective practice specifically designed for in-service teachers. It consisted of six units which are Introduction to Reflective Practice, Engaging in Reflective Practice, Implementing Reflective Practice, Supporting Reflective Practice, Assessment and Continuous Improvement, Conclusion, and Action Steps. This guide was given to an expert in teacher education professional development practice for both content and face validity.

3. **Questionnaires:** Two sets of questionnaires were developed and administered to the participating teachers.

4.

a. **Pre-Training Questionnaire on STEM Teachers' Professional Development through Reflective Practice:** This consists of two sections. Section A, which contains demographic information about the respondent, and Section B, which sought information on prior practice and experiences on Reflective practice, including their expectation and needs about reflective practice.

b. **Post-Training Questionnaire on STEM Teachers' Professional Development through Reflective Practice:** This also consists of two sections with respondent demographic information in Section A. Section B is in five parts, which are: Training Evaluation, Learning Application, Future Consideration, and Overall Reflection.

Participants were organized into four training centers, corresponding to their geographical locations, to streamline logistics and minimize costs. The training programme for teachers spanned four days, while facilitators underwent a five-day training programme. The first day was focused on registration, introduction, participant grouping, and initial interactions. The subsequent two days were dedicated to training teachers on reflective practice. On the fourth day, the questionnaires were administered, and teachers collaborated in groups under the guidance of facilitators. This structured approach aims to ensure comprehensive training and effective data collection. The data analysis in this study utilized a range of statistical methods to explore STEM teachers' perceptions and experiences related to reflective practice and professional development training. Descriptive statistics, including means and standard deviations, were used to

summarize teachers' dispositions and perceptions. Paired samples t-tests assessed changes in professional development scores before and after training; these analyses provided a comprehensive understanding of the impact of reflective practices and professional development on teachers' professional growth.

Result

Research Question 1: Would there be a positive disposition of the STEM teachers in Oyo State toward reflective practice?

Table 1: Positive disposition of the STEM teachers in Oyo State toward reflective practice

| N | Mean | SD | T | Df | Sig | MD | Test Value |
|----|------|------|-------|----|------|-----|------------|
| 98 | 4.20 | 0.65 | 14.72 | 97 | 0.00 | 1.2 | 3 |

The analysis in Table 1 was conducted to determine the disposition of STEM teachers in Oyo State toward reflective practice revealed a positive attitude. With a mean disposition score of 4.2 (SD = 0.65) on a Likert scale where 5 represents a highly positive disposition, the result indicates that teachers generally hold favorable views toward reflective practice. A one-sample t-test was used to compare the mean score to a neutral value of 3, and the result ($t(97) = 14.72$, $p < 0.001$) shows that this difference is statistically significant. The mean difference of 1.2 confirms that the teachers' disposition is significantly more positive than neutral.

Research Question 2: Would the training undergone by the STEM teachers have effects on their professional development?

| Pair | Mean | Std. Deviation | t | df | Sig. (2-tailed) |
|------------------------|------|----------------|-------|----|-----------------|
| Pre-test vs. Post-test | -1.3 | 0.45 | -9.24 | 97 | 0.000 |

The results from the paired samples t-test in Table 2 above indicate a significant improvement in STEM teachers' professional development following the training. The mean difference between the pre-test and post-test scores is -1.3, with a standard deviation of 0.45. The negative

value indicates that post-test scores were higher than pre-test scores. The t-test result ($t(97) = -9.24, p < 0.001$) confirms that this difference is statistically significant, suggesting that the training had a substantial and positive effect on the professional development of the teachers.

Research Question 3: How do practicing teachers define and engage in reflective practice?

| Practices | Frequency | Percentage (%) |
|--|-----------|----------------|
| Self-assessment and reflection on teaching | 35 | 71.4 |
| Peer Collaboration and feedback | 28 | 57.1 |
| Use of Student feedback | 20 | 40.8 |
| Action research and documentation | 12 | 24.5 |

The data reveals that STEM teachers engage in reflective practice primarily through self-assessment and reflection on their teaching, with 71.4% of respondents identifying this as a key practice. Peer collaboration and feedback are also a significant component, reported by 57.1% of teachers. Additionally, 40.8% of teachers incorporate student feedback into their reflective practice, while 24.5% engage in action research and documentation. These findings suggest that reflective practice among STEM teachers is largely focused on personal reflection and collaborative efforts, with a smaller emphasis on structured research and external feedback sources.

Research Question 4: How do practicing teachers develop their profession by being reflective practitioners?

| Professional Development Methods | Frequency | Percentage (%) |
|---------------------------------------|-----------|----------------|
| Improved Lesson Planning | 30 | 61.2 |
| Incorporating new teaching strategies | 25 | 51.0 |
| Enhanced students' engagement | 22 | 44.9 |

The analysis in Table 4 shows that practicing teachers significantly enhance their professional development through reflective practices. The most commonly reported method is improved lesson planning, cited by 61.2% of teachers. Incorporating new teaching strategies

follows, with 51.0% of teachers identifying it as a key benefit. Additionally, 44.9% of teachers noted that reflective practice leads to enhanced student engagement. These results highlight that reflective practices are particularly effective in refining lesson planning and teaching strategies, which in turn contribute to better student interactions and learning outcomes.

Discussion of Findings

The finding that STEM teachers in Oyo state have a positive disposition toward reflective practice aligns with recent trends in educational research. This positive attitude is crucial for the successful implementation of reflective practices in STEM education. As noted by Belvis, Pineda, Armengol, and Moreno (2013), teachers who view reflective practice favorably are more likely to engage in it consistently and effectively. This positive disposition may be attributed to increased awareness of the benefits of reflective practice in enhancing teaching quality and student outcomes (Körkkö, Kyrö-Ämmälä, & Turunen, 2016).

The substantial and positive effect of teacher training on professional development corroborates findings from several recent studies. For instance, Darling-Hammond et al. (2017) emphasized the importance of high-quality professional development in enhancing teacher effectiveness. This result underscores the value of investing in comprehensive training programs for STEM teachers. The positive impact may be due to the acquisition of new skills, exposure to innovative teaching methods, and increased self-efficacy among teachers who undergo training (Garet et al., 2001).

The finding that STEM teachers primarily focus on personal reflection and collaborative efforts in their reflective practice, with less emphasis on structured research and external feedback, presents an interesting perspective. This aligns with Schön's (1987) concept of reflection-in-action and reflection-on-action, which emphasizes the importance of personal and immediate reflection in professional practice. However, the limited focus on structured research and external feedback suggests an area for potential improvement. As highlighted by Beauchamp (2015), a more comprehensive approach to reflective practice that incorporates various sources of input can lead to more robust professional growth.

The observation that reflective practices are particularly effective in refining lesson planning and teaching strategies, leading to improved student interactions and learning outcomes, is consistent with current literature. Reflection has been shown to enhance teachers' ability to adapt and improve their instructional approaches (Voerman et al., 2015). This finding reinforces the value of reflective practice as a tool for continuous improvement in STEM education. The positive impact on student interactions and learning outcomes aligns with research by Mathew and Peechattu (2017), who found that reflective teachers are more adept at creating engaging and effective learning environments.

Conclusion

This study on professional development training through reflective practice for STEM teachers in Oyo State has yielded several significant insights. The findings reveal a positive disposition among STEM teachers towards reflective practice and in-service professional development training, regardless of gender or teaching experience. This may include allocating dedicated time for reflection, providing comprehensive training on reflective tools, and fostering administrative support for these initiatives. By addressing these barriers and leveraging the positive dispositions of teachers, there is significant potential to enhance the quality of STEM teaching and, consequently, improve student learning outcomes. Future research should focus on developing and evaluating targeted interventions to overcome the identified challenges and further integrate reflective practice into STEM education.

Recommendations

1. The school administrators should implement structured time allocations for reflective practice within STEM teachers' schedules to address the challenge of time constraints.
2. Government agencies and School administrators should develop and provide comprehensive training programs on reflective tools and techniques, tailored specifically for STEM educators.
3. Schools should establish a supportive administrative framework that encourages and facilitates ongoing reflective practice and professional development for STEM teachers.

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