SCIENCE TEACHERS' SELF-EFFICACY IN TEACHING DIFFERENT K TO 12 SCIENCE SUBJECTS: THE CASE OF CAGAYAN DE ORO CITY, PHILIPPINES

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ABSTRACT: *The Philippines has shifted to a new K to 12 Curriculum in an attempt to address the pressing concerns raised on the quality of education in the country. The change in the curriculum presented a mismatch problem between in-service teachers. Hence, this research aimed at examining self-efficacy beliefs and subject-specific self- science teachers. Both groups had satisfactory levels of PSTE and STEO. Primary teachers were most confident in teaching chemistry, biology for high school teachers and both groups were least confident in teaching physics. These results were believed to be due to the limited experience of the teachers.*

Keywords: Curriculum design, K to 12 Curriculum, Professional Development, Science Teacher, Teacher education, Teaching confidence

INTRODUCTION

The Philippines was the only country in the Southeast Asian Region and one of the only three countries in the world with a ten-year basic education program before entry to the university level in 2012 [1]. This prompted the National Government, through the Department of Education, to pass into law the Republic Act No. 1033 or the Enhanced Basic Education Act of 2013 to address the clamor of the deteriorating state of education in the country, which was then fully implemented in 2016, with its first graduates in 2018. This law, in a nutshell, institutionalized the kindergarten program and added two more years (Senior High School) to the existing basic education program. These changes in the curriculum aimed at giving learners an equal opportunity to receive quality education based on an enhanced and decongested curriculum, which is recognized and comparable to international standards [2]. Through this legislation, science, as a subject, underwent a major revamp [3]. The different science concepts and applications are now taught using a spiraling progression approach, where the scope and sequence of contents are developed such that concepts and skills are revisited at each grade level to allow mastery from one level to another [4]. Science teachers are required to teach all the specializations of science in each grade level with increasing difficulty and complexity [5]. This becomes a challenge to current in-service teachers since they are products of an old science teacher-education curriculum. In the early teacher-education curriculum for science teachers, science teachers are prepared to teach a specialized field (e.g., biology, chemistry, and physics) instead of learning all sciences in their undergraduate years. In addition, a current study showed a moderate level of scientific literacy among science teachers [6]. This clearly presents a mismatched curriculum between learners and teachers.

This current dilemma urges teacher-education institutions to develop better curricula for science teachers that address this revision in the existing K to 12 education program. Several researchers noted the importance of addressing the issue of limited science content preparedness [7, 8]. Some efforts have been made to revise the existing teacher education curricula through the different issuances of standards, policies, and guidelines of the Professional Regulation Commission by adding more content courses, but this only addresses the existing preservice teachers. The problem with current in-service teachers is still not resolved. To answer this, other researchers proposed to give close attention to teachers' self-efficacy beliefs [9, 10] in addressing this issue. As suggested, the science teacher's self-efficacy may be one area that has been overlooked in addressing this concern [1]. A teacher's self-efficacy beliefs have been described as the teacher's evaluation of his or her capabilities to enable achievement of desired learning outcomes and to engage students in learning and performance [11].

Self-efficacy beliefs play an essential role in determining teaching practices, which includes choosing appropriate instructional activities, organizing lessons, and preparing oneself to handle challenging situations [12]. Teachers with high self-efficacy are more likely to utilize inquiry-based practices in their teaching and provide learner-centered environments to their students [13]. On the other hand, teachers with low self-efficacy became very reliant on textbooks and prescribed material, which prohibits students from developing their critical thinking, creativity, and conceptual understanding [14]. Because of the importance of examining the self-efficacy beliefs of science teachers, the Science Teaching Efficacy Belief Instrument B (STEBI-B) was developed by Bleicher [16]. This instrument assesses science teaching efficacy within two scales: personal science teaching efficacy (PSTE) and the science teaching expectancy outcome (STEO).

There is a consensus among different researchers that the beliefs held by teachers are carried with them to their future classrooms [9, 14, 15]. The existing in-service teachers come from an old curriculum and may bring their previous experiences to their current teaching tasks, which may pose a problem. It is then imperative to examine the beliefs of these teachers as a baseline in improving teacher-education curricula and providing additional professional development programs. Much of the available foreign literature regarding self-efficacy is focused on the personal aspect of self-efficacy towards science teaching. This often results in the labeling of science teachers as having high, medium, or low levels of self-efficacy towards science teaching without specifying the exact science subjects they lack the confidence to teach, such as earth and space science, biology, chemistry, or physics. In the local context, no study yet examined the subject-specific self-efficacy of science teachers. Limited published articles are also available locally on the self-efficacy of science teachers. This research aims to determine the science teacher's self-efficacy towards science teaching and specifying the exact science subjects teachers lack the confidence to teach.

METHODS

This study utilized a descriptive survey research design. The main goal of this study is to determine the levels of personal science teaching efficacy and subject-specific self-efficacy of primary and high school science teachers. Data collection took place in the respective schools of the participants. Ample time was given to the respondents to assure the reliability and validity of results. Data encoding and analyses took place at the University of Science and Technology of Southern Philippines. In this study, 100 primaries (Grade 3 to 6) and 100 high schools (Grade 7 to 10) teachers were invited and considered as the sample. Incomplete questionnaires were considered as mortality and were no longer included in the analysis of data. A total of 92 teachers for primary and 88 teachers for high school was considered as the sample after a quality check of their respective questionnaires.

The personal aspect of self-efficacy towards science teaching (PSTE and STEO) was determined using Science Teaching Efficacy Belief Instrument (STEBI-B) modified by Bleicher [16] and the subject-specific self-efficacy (SSSE) was assessed using the instrument developed by the researchers based on the K to 12 Curriculum Guide of the Department of Education, Philippines. The approval of the utilization of the instrument in this study was already obtained from the authors. The research instrument was reviewed in terms of its content and face validity with the help of experts in chemistry, biology, and physics education from a nearby university. They were given ample time to review the instruments. The instruments were then revised based on the comments and suggestions of the content experts. The revised instrument was then pilot-tested to 45 science teachers from the Division of Cagayan de Oro. The answers were then tabulated and analyzed using an Item Analysis software to check for its reliability. The STEBI-B and Subject-specific Self-Efficacy instruments were also subjected to internal consistency reliability using Cronbach's alpha with a value of 0.81 and 0.95, respectively.

Participation in the study was voluntary, and the highest priority was given to ensure the confidentiality and anonymity of all questionnaires and responses of all participants. Necessary measures were also taken into account to ensure that the participants were not harmed in any way. Study objectives were clearly explained to all participants prior to the data collection [17]. The method, as well as the research instrument utilized in this study, were thoroughly reviewed for ethical considerations by the university research office through our research program officers and external reviewers, which served as the ethics review board.

FINDINGS

Personal Science Teaching Efficacy

The overall Personal Science Teaching Efficacy (PSTE) of the respondents is 3.11 for primary school teachers and 3.22 for high school teachers, which is both satisfactory levels. The highest levels of personal efficacy were noted in statement #1 for both primary and high school teachers. This indicates that teachers possess high confidence that they will be able to find different teaching strategies to teach science effectively. The PSTE levels of both groups of teachers are comparable to each other. This indicates that their science teaching efficacy does not differ even they are teaching at different levels.

Science Teaching Expectancy Outcome

As shown in Table 2, the primary school and high school teachers possessed a satisfactory level of Science Teaching Expectancy Outcome (STEO), with 3.07 and 3.05, respectively. Comparable results between the two groups of teachers signify that the grade level they are teaching does not affect their teaching expectancy outcome. The highest mean level of science teaching expectancy outcome for primary school teachers is that of statement #2 (3.48). This means that teachers are aware that the success of their students is one way or another dependent on their effective use of various teaching strategies. Whereas for high school teachers, they have the highest mean in statement #4 (3.53), which means that teachers recognize that the poor science background of students can be improved by effective science teaching.

Subject-specific self-efficacy (SSSE)

As shown in Table 3, primary science teachers had the highest perceived capability of teaching chemistry followed by earth and space science, biology, and then physics. For high school teachers, they are more confident teaching biology followed by earth science, chemistry, and physics. For both primary and high school teachers, physics seemed to be their least confident science to teach, and earth and space science consistently placed second for both levels.

In a more detailed look, Table 4 summarizes the different topics primary and high school teachers are least confident in teaching. It is noteworthy to mention that both primary and high school teachers find constellations and heavenly bodies, reproduction and genetic variation, chemical reactions, and electricity and motion topics to be their least confident to teach.

DISCUSSION

Personal self-efficacy has been considered to be an essential construct in teacher education and teacher professional development [18]. Teachers who possess high levels of self-efficacy have confidence that they are adequately trained or possess the experience to develop teaching strategies to overcome challenges in student learning. The satisfactory level of PSTE could be since it is mostly affected by the amount of time spent in teaching science to children in the classroom. As reported by Walag, Fajardo, Bacarrisas, and Guimary (2019), the majority of primary and high school teachers possess less than five years of teaching experience. This could be the reason for their satisfactory levels of PSTE. Also, beginning teachers noted to have low confidence tend to limit teaching using engaging strategies [20]. Moreover, mastery of experience help teachers develops efficacy beliefs [12]. This suggests that going through the process of actual teaching, like preparing lessons and teaching science lessons, possess positive effects on PSTE. This implies that teacher education programs can develop efficacy beliefs in students by providing them with the opportunity to prepare and teach science lessons consistently [18]. Experiences provided to students under teacher education programs must be aimed at long term development of teacher efficacy, so when they become teachers, students under them can significantly benefit from their high levels of efficacy towards science teaching [21] although experiences provided on student teaching must be strictly monitored since the literature is divided on how it contributes to the totality of teaching efficacy. Some studies reported an increase of efficacy during student teaching [22, 23] although others have found no or a declining level of efficacy over the years of preparation [24, 25].

The levels of PSTE can also be increased by providing a well-tailored professional development for science teachers should be anchored on providing opportunities for teachers to develop mastery experience, vicarious experience, physiological and emotional arousal, and social persuasion. In this way, teachers develop and strengthen healthy beliefs about science teaching, an important educational concern in this generation [21]. Further, when designing professional development activities, science contents must be taught with positive, meaningful, and engaging science content as this is known to boost PSTE [8]. It is also good to note that Statement #1 had the highest mean compared to all other statements since this refers to their positive attitude towards the teaching of science. In the Tri-component theory, a positive attitude helps better solidify a person's efficacy beliefs.

The level of PSTE was also found to be independent and not correlated with an educational qualification, which highlights the importance of providing opportunities to develop efficacy and expectancy outcomes during teaching preparatory courses [26]. This indicates that whether a teacher has only a bachelor's degree or with a teacher license, it does not affect their beliefs about teaching efficacy. This could be due to the fact the teaching efficacy is best predicted by both context and subject matter and not whether the teacher has a license or not. This could imply that, to better the teaching efficacy of teachers, professional development must be aligned to improving the subject matter expertise of teachers. Moreover, teaching efficacy can also be dependent on the level of understanding of societal perceptions of their role in the classroom, perceptions of support they get for teaching, the opportunities to attend professional development training, and their motivation to continue teaching [26].

Science Teaching Expectancy Outcome (STEO) is the notion that an intention to act is based on the expected success of that action despite the conditions at home or in the environment [16, 18]. This concept can be extended to how teachers view his or her capabilities up to view to teachers in general. In other words, STEO is a belief that a teacher can make a difference in the academic performance of students. Teachers who possess low STEO may believe that they cannot do much to improve student's motivation and performance. This is important since this supports the notion that those who believe that student learning is possible might also be more likely to use teaching strategies that allow students to learn more.

The satisfactory levels of STEO can be explained by the fact that the majority of the respondents have less than five years of teaching experience. To increase STEO of prospective teachers, teacher education students must be provided with opportunities to actively participate in frequent and prolonged field experiences throughout their program of study [8]. This means that when a teacher is more experienced, they have better STEO. This could mean that in the design of a science teacher education curriculum, more emphasis on field experiences coupled with a significant amount of content could bolster the quality of science education in the country. Moreover, teaching experience positively affects expectancy outcomes since this can be based on the teacher's previous experience [27]. Although, another school of thought suggested that extensive teaching experience does not necessarily mean higher teacher outcome expectancy beliefs since this construct is defined by both context and subject matter [26, 28].

The mean level of STEO (3.07 and 3.05) is highly comparable to the mean level of PSTE (3.11 and 3.22) with a very little difference. This is in consonance with the idea that teachers who exhibit high efficacy also show concern for low achieving students [26]. Moreover, teachers who have higher self-efficacy may have a more humanistic perspective towards classroom management and towards learner's achievement [29]. This result can be considered to be good since when teachers acknowledge the belief that students play an active role in learning, they utilize teaching strategies that are engaging and active. Moreover, graduate programs might also make teachers more aware of the impact of active student engagement on learning [27].

Subject-specific self-efficacy was measured using a researcher-developed Likert scale based on the competencies derived from DepEd K to 12 Curriculum Guide. Due to the type of data gathering and research method utilized, results on this question need to be interpreted with caution. Moreover, limited literature was found to expound the construct on subject-specific teaching efficacy. This result in SSSE is contradictory to the results of Yilmaz-Tuzun (2008), where preservice teachers had the lowest levels of self-efficacy in teaching chemistry and physics. Although SSSE in earth and space science (second highest) seemed to be consistent with the results in SL (highest). This could be because strong science content knowledge can be translated into higher levels of self-efficacy beliefs by reducing anxiety about science teaching and enhancing positive attitudes towards science [31].

Respondents also reported having the lowest level of self-efficacy in teaching in physics which is in agreement with the results of Yilmaz-Tuzon. This could be due to the nature of the subject. Unlike biology and earth and space science, teaching physics seems to be challenging since physics concepts are abstract in nature. Primary students must acquire a certain level of cognitive development where they can develop mental images of a complex subject that they have never observed first hand be able to fully understand the abstract nature of physics. This becomes a challenge to the teacher to find means how to present physics concepts in a way understandable to primary level students. As shown in Table 4, these concepts seem to be abstract for most of the students, thus may present more difficulties to teachers in looking for appropriate teaching strategies.

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Table 1. Personal Science Teaching Efficacy

Statement	Primary School Mean ± SD	High School Mean ± SD
1. I continually find better ways to teach science.	3.61 ± 0.59	3.78 ± 0.56
2. Even if I try very hard, I cannot teach science as well as I teach most subjects.*	3.08 ± 0.90	3.34 ± 0.87
3. I know the steps necessary to teach science concepts effectively.	3.03 ± 0.47	3.18 ± 0.53
4. I am not very effective in monitoring science experiments.*	2.65 ± 0.81	2.77 ± 0.84
5. I generally teach science ineffectively.*	3.26 ± 0.77	3.45 ± 0.71
6. I understand science concepts well enough to be effective in teaching science.	3.21 ± 0.56	3.26 ± 0.72
7. I find it difficult to explain to students why science experiments work.*	2.89 ± 0.77	2.99 ± 0.71
8. I am typically able to answer students' science questions.	3.17 ± 0.50	3.11 ± 0.38
9. I wonder if I have the necessary skills to teach science.*	2.71 ± 0.80	2.77 ± 0.86
10. Given a choice, I will not invite the principal to evaluate my science teaching.*	3.34 ± 0.88	3.33 ± 0.75
11. When a student has difficulty understanding a science concept, I usually am at a loss as to how to help the student understand it better.*	2.92 ± 0.91	3.07 ± 0.87
12. When teaching science, I usually welcome student questions.	3.49 ± 0.79	3.69 ± 0.87
13. I do not know what to do to turn students on to science.*	3.07 ± 0.83	3.13 ± 0.69
Total	3.11 ± 0.45	3.22 ± 0.38
Description	Satisfactory	Satisfactory

*responses to these statements were reverse-encoded

Table 2. Science Teaching Expectancy Outcome

Statement	Primary School Mean ± SD	High School Mean ± SD
1. When a student does better than usual in science, it is often because the teacher exerted a little extra effort.	2.93 ± 0.98	2.92 ± 0.87
2. When the science grades of students improve, it is often due to their teacher having found a more effective teaching approach.	3.48 ± 0.69	3.45 ± 0.66
3. If students are underachieving in science, it is most likely due to ineffective science teaching.	2.58 ± 0.87	2.39 ± 0.86
4. The inadequacy of a student's science background can be overcome by good teaching.	3.36 ± 0.71	3.53 ± 0.62
5. The low science achievement of some students cannot generally be blamed on their teachers	3.07 ± 0.77	3.28 ± 0.90
6. When low-achieving children progress in science, it is usually due to the extra attention given by the teacher.	3.03 ± 0.84	3.08 ± 0.70
7. Increased effort in science teaching produces little change in some students' science achievement.*	2.48 ± 0.94	2.63 ± 1.02
8. The teacher is generally responsible for the achievement of students in science.	3.14 ± 0.81	2.80 ± 0.76
9. Students' achievement in science is directly related to their teacher's effectiveness in science teaching.	3.36 ± 0.64	3.10 ± 0.66
10. If parents comment that their child is showing more interest in science at school, it is probably due to the performance of the child's teacher	3.23 ± 0.76	3.30 ± 0.54
Total	3.07 ± 0.36	3.05 ± 0.31
Description	Satisfactory	Satisfactory

*responses to these statements were reverse-encoded

Table 3. Subject-specific self-efficacy of science teachers

Subject	Primary School Mean ± SD	High School Mean ± SD
Earth and Space Science (ESSE)	3.36 ± 0.47	3.19 ± 0.48
Biology (BE)	3.32 ± 0.50	3.23 ± 0.60
Chemistry (CE)	3.37 ± 0.51	3.13 ± 0.59
Physics (PE)	3.20 ± 0.54	3.01 ± 0.55

Table 4. The topics science teachers' least confident in teaching

Subject	Primary School	High School
Earth and Space Science	Constellations, phases of the moon, and heavenly bodies	Comets, meteors, and asteroids, a constellation in relation with earth's orbit, and the relationship of volcanoes, earthquakes, and mountain ranges
Biology	Nonflowering plant reproduction, interactions in intertidal and estuarine ecosystems, and interactions in tropical rainforests, coral reefs, and mangroves	Meiosis and genetic variation, genetic information in genes of chromosomes, and DNA mutation
Chemistry	Chemical reactions, types of mixtures, and techniques in separating mixtures	Mole concept, structure, and function of biomolecules, chemical reactions related to biological and industrial processes
Physics	DC circuits and electricity and magnetism, motion in terms of distance and time, the effect of gravity and friction in moving objects	Projectile motion, impulse, and momentum, electromagnetic spectrum, and electricity and magnetism in motors and generators

CONCLUSION

This study investigated the levels of personal science teaching efficacy and subject-specific efficacy of both primary and high school science teachers of Cagayan de Oro City, Philippines. The level of self-efficacy was reported in terms of personal science teaching efficacy and science teaching expectancy outcome. The science teachers scored satisfactory in both personal science teaching efficacy and science teaching expectancy outcome. This was believed to be due to their limited actual teaching experience. In terms of subject-specific self-efficacy, teachers reported being more confident in teaching chemistry, followed by earth and space science, biology, and physics. Primary teachers were found to be more confident in teaching chemistry, whereas high school teachers were most confident in biology. Both groups noted to be less confident in teaching physics, which could be due to the nature of this subject. It is with these reasons that it is recommended that in the design of professional development programs for teachers, much attention should be given to the topics that teachers are least confident in teaching. In addition, in the design of teacher-education curricula, experience in the actual teaching of different science subjects must be integrated to address their self-efficacy beliefs early on hopefully.

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