SCIENCE TEACHER'S PERSONAL AND SUBJECT-SPECIFIC SELF-EFFICACY IN TEACHING SCIENCE: THE CASE OF EL SALVADOR CITY, PHILIPPINES

Mary Allein Antoenette C. Bug-os*[,1,3], Angelo Mark P. Walag[1,3] and Maria Teresa M. Fajardo[1,2],
[1]Department of Science Education, University of Science and Technology of Southern Philippines, Cagayan de Oro City, Philippines
[2]Extension and Community Relations Division, University of Science and Technology of Southern Philippines, Cagayan de Oro City, Philippines
[3]Science and Mathematics Advanced Researches in Teaching Laboratory, University of Science and Technology of Southern Philippines, Cagayan de Oro City, Philippines
*Corresponding author's email address and address: allein.bugos@ustp.edu.ph

ABSTRACT: *The Philippines had a major revamp in its basic education curriculum, particularly the implementation of the new K to 12 curriculum. Within the five years from its full implementation, several challenges were identified by curriculum experts, research scholars, and even the in-service teachers. This problem is evident in the revisions made in the science curriculum. The curricular change has presented a mismatch problem between in-service science teachers and the current science curriculum. Hence, this study aimed at examining the topics that the science teachers' least confident in teaching in the elementary and high school science curriculum. In this manner, the gap between an in-service science teacher and the current science curriculum will be revealed. This study utilized a descriptive research design with adapted questionnaires from the literature. The PSTE and STEO have satisfactory levels for elementary and high school teachers. Elementary teachers were most confident in teaching chemistry, while high school teachers were most confident in teaching biology. Teaching physics is the least confident area in science for both groups. The results were believed to be due to the limited years of actual science teaching experience. The findings of this study can be used to design and develop evidence-based courses to address the gap between science teacher's efficacy and the current science curriculum of the country.*

Keywords: science curriculum, science teaching self-efficacy, subject-specific self-efficacy, teaching confidence, science education

INTRODUCTION

The K-12 curriculum in the Philippines is in its fifth year from its full implementation. The new curriculum aims to improve programs of learning, access to quality education, form individuals who can contribute to the broader community, and boost the global competitiveness of the Filipino workforce [1]. With these aims, a significant change was done in this transition, such as the "spiral approach" in the curriculum [2]. It is designed by building on the same concepts in each grade level and increasing complexity [3, 4]. When a student masters an initial topic, new knowledge is introduced in the next lesson enabling him/her to reinforce what is already learned. A rich breadth and depth of knowledge are achieved in the end [5]. This is to ensure the mastery of knowledge and skills after each grade level.

Along with this transition, the new science curriculum has many improvements. The new science program incorporates the different disciplines in science which are life science, physics, chemistry, and earth science in every grade level [6]. Each grade has an enhanced and decongested curriculum [7] in which learners must develop the core competencies relevant in their further education or working life [8]. The spiral progression of the science curriculum calls for new perspectives in implementing the teaching and learning process [9]. Science teachers are required to teach all the specializations of science in each grade level with increasing difficulty and complexity [10]. But the current K to 12 teachers are specialized in a specific field in science. However, the new curriculum required them to teach all the areas in science in a spiral progression approach. There has been a discrepancy in teachers' preparation in science teaching [11] even though teachers are in the place to shape better-educated future generations [12].

This situation urges teacher-education institutions in the Philippines to develop appropriate science teachers' curricula for the K to 12 programs in basic education. With this, the Commission on Higher Education issued a memorandum on the policies, standards, and guidelines for the new undergraduate programs including science. The new science teacher education program is designed to equip learners with adequate and relevant competencies to teach their specialization at the secondary level [13]. Still, the current efforts prepare for the preservice teachers. The challenge with current in-service teachers is still unsettled. Several researchers suggested focusing on self-efficacy beliefs in addressing the challenge [14, 15].

In a broader term, self-efficacy is an individual's perceived capabilities to attain designated types of performances and achieve specific results [16]. It influences how an individual thinks, feels, motivates, and acts [17]. Specifically to science education, a teacher's efficacy is a teacher's belief or judgment about own abilities to teach science effectively with innovative techniques [18–20]. It also considers their personal weaknesses in terms of the specific teaching context [21]. Therefore it has predictive value because it influences students' achievement, attitude, and affective growth.

Several foreign studies regarding teachers' self-efficacy indicate strong links between teacher self-efficacy and factors such as instructional quality and students' academic achievement [22]. Yet, much of this research approach self-

efficacy from the perspective of teaching, but few studies have attempted to distinguish the actual science subjects that the in-service science teachers lack confidence in teaching. In the local setting, no study yet examined the specific topics that the science teachers' least confident in teaching and subject-specific self-efficacy of science elementary and high school teachers. Limited published articles are also available locally on the self-efficacy of science teachers. This research aims to determine the teachers' science teaching efficacy and specifying the topics in each science subject teachers lack the confidence to teach.

METHODS

A descriptive survey research design was utilized in this study. This study aims to determine the levels of personal science teaching efficacy and subject-specific self-efficacy of elementary and high school science teachers. The El Salvador City division office assisted data collection through electronic forms. Ample time was given to the participants to assure the reliability and validity of the results. In this study, teachers' profiling was conducted. Forty-nine (49) elementary (Grade 3 to 6) and eighteen (18) high schools (Grade 7 to 10) teachers were considered as the sample, which has a total of 67 Science teachers. Data analyses took place at the University of Science and Technology of Southern Philippines. 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, and the subject-specific self-efficacy (SSSE) was assessed using the instrument developed by Walag et al. (2020) based on the K to 12 Curriculum Guide of the Department of Education, Philippines. The approval of the utilization of the tool 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 sufficient time to review the instruments. The instruments were then revised based on the comments and suggestions of the content experts. The revised tool was then pilot-tested to 45 science teachers from a certain division in the region. The answers were then tabulated and analyzed using Item Analysis software to check for their 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.

The confidentiality and anonymity of responses of all participants were the highest priority in this study. All necessary measures were also taken into account to ensure that the participants were not harmed in any way. The objectives were clearly explained to all participants before the data collection. The method and the research instrument utilized in this study were carefully 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

Science Teachers' Profile

The majority of the elementary teacher-participants are teaching Grade 3 Science with less than ten years of teaching experience. These generalist teachers are escalating their knowledge and skills because of the evidence that several of the teachers have master's or doctorate degrees. The high school science teachers are mostly teaching Grade 7 Science. Although the majority have five years of teaching experience, the teachers are mostly master's degree holders. This indicated that teachers go the extra mile to advance their knowledge and skills by taking graduate studies.

Table 1. The Science Teachers' Profile of the Division of El Salvador City

Parameter	Primary School (n=49)		High School (n=18)	
	f	%	f	%
Science Level Taught				
Grade 3/7	30	61.22%	4	27.80%
Grade 4/8	7	14.29%	3	16.70%
Grade 5/9	3	6.12%	4	22.20%
Grade 6/10	9	18.37%	6	33.33%
Teaching Experience (years)				
21 or more	13	26.53%	-	-
16 – 20	5	10.20%	-	-
11 – 15	3	6.12%	1	5.55
6 – 10	11	22.45%	5	27.78
0 – 5	17	34.70%	12	66.67
Educational Attainment				
Bachelor's degree	36	73.47%	8	44.40%
Master's degree	10	20.41%	10	55.60%
Doctorate degree	3	6.12%	-	-

Personal Science Teaching Efficacy

The respondents' overall Personal Science Teaching Efficacy (PSTE) is 3.04 for elementary school teachers and 3.21 for high school teachers, which are both satisfactory levels. The highest personal teaching efficacy levels were noted in statements #1 and #12 for elementary school teachers. This indicates that teachers at the elementary level possess high confidence that they will find varied teaching strategies in teaching science. Also, elementary school teachers believe that students' queries are recognized to have effective science teaching. Likewise, the highest level of personal efficacy was noted in statement #1, followed by statement #12. The PSTE levels of the two groups of teachers are comparable to each other. This indicates that the science teaching efficacy of the groups does not differ even they are teaching at different levels.

Science Teaching Expectancy Outcome

As shown in Table 2, the elementary and high school teachers possessed a satisfactory Science Teaching Expectancy Outcome (STEO) level, with 2.97 and 3.13, respectively. The highest mean level of science teaching expectancy outcome for elementary school teachers is statement #2 and #4 (3.39). This means that the teachers recognize that the students' difficulty in science due to lack of background knowledge can be improved by using a wide range of teaching strategies suited to the students' needs. Whereas for high school teachers, they have the highest mean

in statement #4 and #6 (3.50), which means that teachers viewed that the progress of the low-achieving students can be elevated through outspread consideration on their needs.

Subject-specific self-efficacy (SSSE)

As shown in Table 3, elementary science teachers had the highest perceived capability of teaching chemistry, followed by biology, earth and space science, and then physics. The high school teachers are more confident teaching biology, followed by earth science, chemistry, and physics. Physics seemed to be their least confident science to teach for both elementary and high school teachers. In a more detailed look, Table 4 summarizes the different topics which the elementary and high school teachers are least confident in teaching. The elementary and high school teachers have varied least confident topics to teach except for constellations.

DISCUSSION

Personal teaching efficacy is one of the most central mechanisms to analyze professional development programs [23]. It has to do with teachers' perceptions of competence in specific tasks and are often associated with pedagogical content knowledge [24]. Teachers with a high sense of self-efficacy are confident and exhibit a repertoire of ideas and use new strategies in teaching that ultimately shape students' educational experiences in learning science [19, 25]. They also persist in the face of student failure, are more resilient when facing setbacks, and are more likely to provide special assistance to students who are struggling (Cone, 2009)

The satisfactory level of PSTE could be affected by the actual science teaching experience [3]. The years of teaching experience were positively related to personal teaching self-efficacy, which means that an increase in teaching experience would increase personal teaching self-efficacy [26]. Based on the teachers' profile, most elementary and high school teachers possess less than five years of teaching experience, the reason for their satisfactory levels of PSTE. The length of teaching experience can develop stronger self-efficacy beliefs [20]. Consistent with the previous study, novice teachers scored significantly lower in teaching efficacy than experienced teachers [27].

Teachers who have high efficacy create mastery experiences for their students [28] and practical matters, such as instructional and classroom management [21]. The beginning teachers who have lower levels of teacher self-efficacy beliefs have difficulty classroom management, like students' behaviors. Thus, if teachers acquire more incredible experience, their self-efficacy beliefs increase [29], [30]. Teachers undergoing the process of actual science teaching have a positive effect on PSTE. Mastery experiences significantly contribute to teacher efficacy [31]. Direct communication with students and preparing teaching activities can affect teachers' teaching efficacy [21].

Although several teachers hold master's or even doctorate degrees, a well-tailored professional development for science teachers should be considered to grow science teaching efficacy. Study shows that teachers' professional development efforts positively affect teacher efficacy [32]. Also, the frequency of participation in these programs has shown a significant positive relationship [33]. When used as a pivot point in the design of professional development programs, self-efficacy could be the potential value of a set of practical tools like feedback [34]. Thus, providing opportunities and experiences that are positive, meaningful, and engaging is essential [35].

Science Teaching Expectancy Outcome is a belief that a teacher can make a difference to a students' academic performance [36]. A belief in how well students can actually be taught, given limitations such as their family situation, school conditions, or academic ability [37]. Often, the low outcome expectancy teachers perceived teaching as a solo experience with little recognition of students' interactive role in the learning process [24].

The satisfactory levels of STEO can be explained by the fact that the majority of elementary and high school teachers have less than five years of science teaching experience. Previous studies showed that as teachers grew in their science teaching experience, their science teaching efficacy and outcome expectations also grew. [36, 38]. Experienced teachers can determine appropriate instructional strategies in their teaching and expect student success [36]. Evident in this study that elementary and high school teachers have the same opinion that despite the inadequacy of a student's science background, it can be overcome by good teaching.

The mean level of STEO (2.97 and 3.13) is highly comparable to the mean level of PSTE (3.04 and 3.21) with very little difference. Teachers' beliefs in their efficacy are significant because they affect the learning environments they create and the students' academic progress [28]. Teachers who are high in science self-efficacy feel capable of teaching science and will likewise persist in their efforts to reach unmotivated students [39].

A researcher-developed Likert scale instrument was used to measure the subject-specific self-efficacy of the teachers. The instrument was based on the competencies derived from DepEd K to 12 Curriculum Guide. The SSSE result for high school teachers is in accord with the results of Sultan (2020), which showed that the highest self-efficacy level is in biology, followed by earth science, chemistry, and physics. Chemistry is the highest level of efficacy for elementary school teachers, which is different from Yilmaz-Tuzun's (2008) results, where one of the lowest levels of self-efficacy is in teaching chemistry. However, both elementary and high school teachers had low self-efficacy levels in teaching physics [15]. One possible reason is the fewer number of physics subjects in their prior education [40]. The previous school science experiences are considered one of the variables to influence efficacy [35], [42]. The teachers' lack of confidence to teach science has mainly been attributed to their poor background knowledge [43]. Physics is different from other school subjects because it requires faster progression and is more conceptually demanding [43]. The elementary and high school teachers are least confident in teaching electricity-related topics. This particular concern demonstrates conceptual inadequacies and epistemological uncertainties (for concepts and models/analogies and nature of physics) [44].

Consequently, high school teachers are pretty confident in teaching biology because of their good cognitive background in the subject [44]. These teachers seemed to be less confident in some topics like the structure and function of

mitochondrion and information stored in DNA which are included in the biology concepts perceived too difficult to teach [45]. The elementary teachers are confident in teaching chemistry but not in teaching mixture characteristics and different techniques to separate mixtures. These topics require some understanding gained implicitly from laboratory experience [46]. In addition, the topics in chemistry for high school are consistent with the observation of some authors where they even developed a mobile application for ionic bonding [47]. Table 5 also shows the topics science teachers' least confidence in teaching in earth and space science for elementary and high school teachers.

Table 2. Personal Science Teaching Efficacy

	Statement	Primary School (n=49) Mean ± SD	High School (n=18) Mean ± SD
1.	I continually find better ways to teach science.	3.47 ± 0.50	3.72 ± 0.46
2.	Even if I try very hard, I cannot teach science as well as I teach most subjects.*	2.90 ± 0.87	3.17 ± 0.71
3.	I know the steps necessary to teach science concepts effectively.	3.08 ± 0.49	3.33 ± 0.49
4.	I am not very effective in monitoring science experiments.*	2.57 ± 0.71	2.78 ± 0.88
5.	I generally teach science ineffectively.*	3.06 ± 0.66	3.22 ± 0.65
6.	I understand science concepts well enough to be effective in teaching science.	3.16 ± 0.51	3.26 ± 0.72
7.	I find it difficult to explain to students why science experiments work.*	2.88 ± 0.60	3.17 ± 0.71
8.	I am typically able to answer students' science questions.	3.16 ± 0.43	3.22 ± 0.55
9.	I wonder if I have the necessary skills to teach science.*	2.69 ± 0.65	3.11 ± 0.68
10.	Given a choice, I will not invite the principal to evaluate my science teaching.*	3.06 ± 0.47	3.22 ± 0.65
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.*	2.98 ± 0.69	3.11 ± 0.76
12.	When teaching science, I usually welcome student questions.	3.47 ± 0.54	3.56 ± 0.51
13.	I do not know what to do to turn students on to science.*	3.00 ± 0.71	3.11 ± 0.58
	Total	3.04 ± 0.30	3.21 ± 0.43
	Description	Satisfactory	Satisfactory

*responses to these statements were reverse-encoded

Table 3. 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.	3.12 ± 0.70	3.39 ± 0.61
2.	When the science grades of students improve, it is often due to their teacher having found a more effective teaching approach.	3.39 ± 0.57	3.44 ± 0.51
3.	If students are under achieving in science, it is most likely due to ineffective science teaching.	2.54 ± 0.79	2.50 ± 0.86
4.	The inadequacy of a student's science background can be overcome by good teaching.	3.39 ± 0.53	3.50 ± 0.62
5.	The low science achievement of some students cannot generally be blamed on their teachers	3.24 ± 0.56	3.39 ± 0.50
6.	When low-achieving child progress in science, it is usually due to extra attention is given by the teacher.	2.80 ± 0.84	3.50 ± 0.51
7.	Increased effort in science teaching produces little change in some students' science achievement.*	2.08 ± 0.86	2.06 ± 0.87
8.	The teacher is generally responsible for the achievement of students in science.	2.94 ± 0.59	3.17 ± 0.79
9.	Students' achievement in science is directly related to their teacher's effectiveness in science teaching.	3.16 ± 0.55	3.22 ± 0.65
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	3.14 ± 0.68	3.17 ± 0.62
	Total	2.97 ± 0.31	3.13 ± 0.37
	Description	Satisfactory	Satisfactory

*responses to these statements were reverse-encoded

Table 4. Subject-Specific Self-Efficacy of Science Teachers

Subject	Primary School Mean ± SD	High School Mean ± SD
Earth and Space Science (ESSE)	3.25 ± 0.42	3.37 ± 0.48
Biology (BE)	3.28 ± 0.34	3.38 ± 0.44
Chemistry (CE)	3.37 ± 0.56	3.21 ± 0.35
Physics (PE)	3.21 ± 0.44	3.12 ± 0.52

Table 5. The Topics Science Teachers' Least Confident in Teaching

Subject	Elementary School	High School
Earth and Space Science	• The phases of the Moon and the beliefs and practices associated with it • Constellations and the information derived from their location in the sky • Weather patterns and seasons in the Philippines	• Characteristics of comets, meteors, and asteroids • The relationship between the visible constellations in the sky and Earth's position along its orbit
Biology	• Reproduction of non-flowering plants • Reproduction among humans, animals, and plants and certain observable characteristics that are passed from parents to offspring • The major organs of the human body and how they work together to form organ systems	• The structure and function of mitochondrion as the main organelle involved in respiration • The information stored in DNA is being used to make proteins
Chemistry	• Materials undergo changes due to oxygen and heat • Different types of mixtures and their characteristics • Different techniques to separate mixtures	• The identity of a substance according to its atomic structure • The particle nature of matter as a basis for explaining properties, physical changes, and structure of substances and mixtures • How gases behave based on the motion and relative distances between gas particles
Physics	• A simple DC circuit and the relationship between electricity and magnetism in electromagnets • Gravity and friction affect the movement of objects • How energy is transformed in simple machines	• Charges and the different charging processes • Current-voltage resistance relationship, electric power, electric energy, and home circuitry • Generation, transmission, and distribution of electrical energy from power plants (hydroelectric, geothermal, wind, nuclear) to home

CONCLUSION

This study examined the levels of science teaching efficacy beliefs and subject-specific efficacy of elementary and high school science teachers of El Salvador City, Philippines. The personal science teaching efficacy and science teaching expectancy outcome of the science teachers scored satisfactorily. This was believed to be due to their limited years of actual science teaching experience. In terms of subject-specific self-efficacy, elementary science teachers reported being more confident in teaching chemistry while the high school teachers are most confident teaching biology. Teaching physics for elementary and high school teachers was noted to be less confident. This could be due to the fewer physics subjects and experiences in their prior education. Consequently, it is recommended that professional development programs draw attention to the least confident topics in physics. In addition, in the design and implementation of teacher-education curricula, varied learning experiences in the different science subjects must be prioritized to attain target competencies and attainment of mastery to address.

ACKNOWLEDGMENT

AMPW and MTMF would like to express their immense gratitude to the University of Science and Technology of Southern Philippines for providing institutional research funding (ROIRP-2018-33). AMPW, MTMF, and MAACB would also express the same gratitude to the Department of Education – Division of El Salvador City for providing logistical support and for allowing the researchers to conduct data collection.

REFERENCES

[1] G. Adarlo and L. Jackson, "For whom is K-12 education: A critical look into twenty-first-century educational policy and curriculum in the

Philippines," in *Educating for the 21st Century: Perspectives, Policies, and Practices from Around the World*, Springer Singapore, 2016, pp. 207–223. doi: 10.1007/978-981-10-1673-8_11.

[2] M. Okabe, "Where does Philippine education go? The 'K to 12' program and reform of Philippine basic education," *IDE Discussion Paper*, vol. 425, no. 425, 2013.

[3] A. M. P. Walag, M. T. M. Fajardo, F. M. Guimary, and P. G. Bacarrisas, "Science Teachers' Self-Efficacy in Teaching Different K to 12 Science Subjects: The Case of Cagayan de Oro City, Philippines," *Science International*, vol. 32, no. 5, pp. 587–592, 2020.

[4] E. C. Valin and S. S. Janer, "Spiral Progression Approach in Teaching Science," *International Journal of Engineering Science and Computing*, vol. 9, no. 3, pp. 19976–19984, 2019.

[5] J. B. Dunton and W. S. Co, "'spiral Progression Approach in Teaching Science and the Performance of Learners in District I, Capiz,'" *Journal of Physics: Conference Series*, vol. 1254, no. 1, 2019, doi: 10.1088/1742-6596/1254/1/012045.

[6] D. R. T. Montebon, "K12 Science Program in the Philippines: Student Perception on its Implementation," *International Journal of Education and Research*, vol. 2, no. 12, pp. 153–164, 2014.

[7] R. A. Laureano, A. A. Espinosa, and R. A. Avilla, "Effects of 'Grade 9 Science Learner's Material' on Students' Self-Regulation and Achievement in Chemistry," *Electronic Journal of Science Education*, vol. 19, no. 8, pp. 28–58, 2015.

[8] OECD, Ed., *Equity and Quality in Education SUPPORTING DISADVANTAGED STUDENTS AND SCHOOLS*. OECD Publishing, 2012. doi: 10.1787/9789264130852-en.

[9] H. De Ramos-Samala, "Spiral Progression Approach in Teaching Science: A Case Study," *KnE Social Sciences*, vol. 3, no. 6, p. 555, Jun. 2018, doi: 10.18502/kss.v3i6.2404.

[10] N. B. T. Digal and A. M. P. Walag, "Self-Efficacy, Study Habits and Teaching Strategies and It's Influence on Student Science Performance: A Cross-Sectional Study," *Asia Pacific Journal of Social and Behavioral Sciences*, vol. 16, pp. 51–76, 2019.

[11] J. R. Orbe, A. A. Espinosa, and J. T. Datukan, "Teaching chemistry in a spiral progression approach: Lessons from science teachers in the Philippines," *Australian Journal of Teacher Education*, vol. 43, no. 4, pp. 17–30, 2018, doi: 10.14221/ajte.2018v43n4.2.

[12] UNESCO, "Guidelines and Recommendations for Reorienting Teacher Education to Address Sustainability," 2005.

[13] CHEd, "CHED Memorandum Order 75 s. 2017. Policies, standards, and guidelines for Bachelor of Secondary Education (BSEd)," 2017. https://ched.gov.ph/wp-content/uploads/2017/11/CMO-No.-75-s.-2017.pdf (accessed May 01, 2021).

[14] M. Tschannen-Moran and P. Mcmaster, "Sources of self-efficacy: Four professional development formats and their relationship to self-efficacy and implementation of a new teaching strategy," *Elementary School Journal*, vol. 110, no. 2, pp. 228–245, Dec. 2009, doi: 10.1086/605771.

[15] D. Menon and T. D. Sadler, "Preservice Elementary Teachers' Science Self-Efficacy Beliefs and Science Content Knowledge," *Journal of Science Teacher Education*, vol. 27, no. 6, pp. 649–673, Oct. 2016, doi: 10.1007/s10972-016-9479-y.

[16] F. Pajares, "Self-Efficacy Beliefs in Academic Settings," 1996.

[17] K. Zulkosky, "Self-Efficacy: A Concept Analysis," *Nursing Forum*, vol. 44, no. 2, pp. 93–102, Apr. 2009, doi: 10.1111/j.1744-6198.2009.00132.x.

[18] P. Cantrell, S. Young, and A. Moore, "Factors Affecting Science Teaching Efficacy of Preservice Elementary Teachers," *Journal of Science Teacher Education*, vol. 14, no. 3, pp. 177–192, Aug. 2003, doi: 10.1023/a:1025974417256.

[19] N. Cone, "Community-Based Service-Learning as a Source of Personal Self-Efficacy: Preparing Preservice Elementary Teachers to Teach Science for Diversity," *School Science and Mathematics*, vol. 109, no. 1, pp. 20–30, Jan. 2009, doi: 10.1111/j.1949-8594.2009.tb17859.x.

[20] S. Shaukat, V. Rao Vishnumolakala, and A. K. Hamdan Alghamdi, "Science Teachers' Perceptions of Personal Science Efficacy Beliefs and Science Teaching in Saudi Arabia, Pakistan, and the United Arab Emirates," *EURASIA Journal of Mathematics, Science and Technology Education*, vol. 2020, no. 8, p. 1866, 2020, doi: 10.29333/ejmste/8290.

[21] M. Poulou, "Personal yeaching efficacy and its sources: Student teachers' perceptions," *Educational Psychology*, vol. 27, no. 2, 2007, doi: 10.1080/01443410601066693.

[22] T. Ramaci, M. Coco, G. Santisi, D. Barni, F. Danioni, and P. Benevene, "Teachers' Self-Efficacy: The Role of Personal Values and Motivations for Teaching," 2019, doi: 10.3389/fpsyg.2019.01645.

[23] K. Seneviratne, J. A. Hamid, A. Khatibi, F. Azam, and S. Sudasinghe, "Teachers' Sense of Efficacy: A Challenge for Professional Development Toward Teaching Science as Inquiry," *Science Education International*, vol. 30, no. 4, pp. 274–283, Dec. 2019, doi: 10.33828/sei.v30.i4.4.

[24] C. Khourey-Bowers and D. G. Simonis, "Longitudinal Study of Middle Grades

Chemistry Professional Development: Enhancement of Personal Science Teaching Self-Efficacy and Outcome Expectancy," *Journal of Science Teacher Education*, vol. 15, no. 3, pp. 175–195, Aug. 2004, doi: 10.1023/b:jste.0000047083.14197.b8.

[25] S. Shohani, A. Azizifar, H. Gowhary, and A. Jamalinesari, "The Relationship between Novice and Experienced Teachers' Self-efficacy for Personal Teaching and External Influences," *Procedia - Social and Behavioral Sciences*, vol. 185, pp. 446–452, May 2015, doi: 10.1016/j.sbspro.2015.03.357.

[26] P. S. Woo and Z. M. Ashari, "Relationship between Teaching Experience with Self-Efficacy and Instructional Strategies Applied among Secondary School Teachers," *Indian Journal of Public Health Research & Development*, vol. 10, no. 4, p. 1448, 2019, doi: 10.5958/0976-5506.2019.00918.5.

[27] S. M. Putman, "Investigating Teacher Efficacy: Comparing Preservice and Inservice Teachers with Different Levels of Experience," *Action in Teacher Education*, vol. 34, no. 1, pp. 26–40, Mar. 2012, doi: 10.1080/01626620.2012.642285.

[28] A. Bandura, "Perceived Self-Efficacy in Cognitive Development and Functioning," *Educational Psychologist*, vol. 28, no. 2, pp. 117–148, 1993, doi: 10.1207/s15326985ep2802_3.

[29] A. Bullock, R. J. Coplan, and S. Bosacki, "Exploring links between early childhood educators' psychological characteristics and classroom management self-efficacy beliefs," *Canadian Journal of Behavioural Science*, vol. 47, no. 2, pp. 175–183, Apr. 2015, doi: 10.1037/a0038547.

[30] T. N. Tok and Ş. Tok, "Novice teachers' classroom management self efficacy beliefs," *Journal of Human Sciences*, vol. 13, no. 3, p. 5595, 2016, doi: 10.14687/jhs.v13i3.4178.

[31] T. Wang'eri and H. Otanga, "SOURCES OF PERSONAL TEACHER EFFICACY AND INFLUENCE ON TEACHING METHODS AMONG TEACHERS IN PRIMARY SCHOOLS IN COAST PROVINCE, KENYA," *Global Journal of Interdisicplinary Social Sciences*, vol. 3, no. 3, pp. 190–195, 2014.

[32] J. H. Yoo, "The Effect of Professional Development on Teacher Efficacy and Teachersí Self-Analysis of Their Efficacy Change," *Journal of Teacher Education for Sustainability*, vol. 18, no. 1, 2016, doi: 10.1515/jtes-2016-0007.

[33] D. Mahler, J. Großschedl, and U. Harms, "Opportunities to Learn for Teachers' Self-Efficacy and Enthusiasm," 2017, doi: 10.1155/2017/4698371.

[34] N. Bray-Clark and R. Bates, "Self-Efficacy Beliefs and Teacher Effectiveness: Implications for Professional Developement," *The Professional Educator*, vol. XXVI, p. 13, 2003.

[35] R. P. Hechter, "Changes in Preservice Elementary Teachers' Personal Science Teaching Efficacy and Science Teaching Outcome Expectancies: The Influence of Context," *Journal of Science Teacher Education*, vol. 22, no. 2, pp. 187–202, Mar. 2011, doi: 10.1007/s10972-010-9199-7.

[36] S. J. M. Desouza, W. J. Boone, and O. Yilmaz, "A study of science teaching self-efficacy and outcome expectancy beliefs of teachers in India," *Science Education*, vol. 88, no. 6. pp. 837–854, Nov. 2004. doi: 10.1002/sce.20001.

[37] J. Utley, C. Moseley, and R. Bryant, "Relationship Between Science and Mathematics Teaching Efficacy of Preservice Elementary Teachers," *School Science and Mathematics*, vol. 105, no. 2, pp. 82–87, Feb. 2005, doi: 10.1111/j.1949-8594.2005.tb18040.x.

[38] C. J. Liu, B. M. Jack, and H. L. Chiu, "Taiwan elementary teachers' views of science teaching self-efficacy and outcome expectations," *International Journal of Science and Mathematics Education*, vol. 6, no. 1, pp. 19–35, 2008, doi: 10.1007/s10763-006-9065-4.

[39] J. D. Ulmer, J. J. Velez, M. D. Lambert, G. W. Thompson, S. Burris, and P. A. Witt, "Exploring Science Teaching Efficacy of CASE Curriculum Teachers: A Post-Then-Pre Assessment," *Journal of Agricultural Education*, vol. 54, no. 4, pp. 121–133, 2013, doi: 10.5032/jae.2013.04121.

[40] A. A. Al Sultan, "Investigating preservice elementary teachers' subject-specific self-efficacy in teaching science," *Eurasia Journal of Mathematics, Science and Technology Education*, vol. 16, no. 5, 2020, doi: 10.29333/ejmste/7801.

[41] O. Yilmaz-Tuzun, "Preservice elementary teachers' beliefs about science teaching," *Journal of Science Teacher Education*, vol. 19, no. 2, pp. 183–204, Apr. 2008, doi: 10.1007/s10972-007-9084-1.

[42] R. E. Bleicher, "Revisiting the STEBI-B: Measuring Self-Efficacy in Preservice Elementary Teachers," *School Science and Mathematics*, vol. 104, no. 8, pp. 383–391, Dec. 2004, doi: 10.1111/j.1949-8594.2004.tb18004.x.

[43] D. C. Rice and A. Roychoudhury, "Preparing More Confident Preservice Elementary Science Teachers: One Elementary Science Methods Teacher's Self-Study," *Journal of Science Teacher Education*, vol. 14, no. 2, pp. 97–126, May 2003, doi: 10.1023/a:1023658028085.

[44] E. Mavrikaki and K. Athanasiou, "Development and Application of an Instrument to Measure Greek Primary Education Teachers' Biology Teaching Self-efficacy Beliefs," *Eurasia Journal of Mathematics, Science & Technology Education*, vol. 7, no. 3, pp. 203–213, 2011.

[45] S. N. Gungor and M. Ozkan, "Evaluation of the Concepts and Subjects in Biology Perceived to be Difficult to Learn and Teach by the Pre-Service Teachers Registered in the Pedagogical Formation Program," *European Journal of Educational Research*, vol. 6, no. 4, pp. 495–508, 2017, doi: 10.12973/eu-jer.6.4.495.

[46] J. Bond-Robinson, "Identifying pedagogical content knowledge (PCK) in the chemistry laboratory Introduction: Pedagogical Content Knowledge (PCK) in Chemistry," 2005.

[47] G. G. Bactong, A. D. H. Sabas, K. M. M. Salva, A. J. B. Lituañas, and A. M. P. Walag, "Design , Development , and Evaluation of CHEMBOND : An Educational Mobile Application for the Mastery of Binary Ionic Bonding Topic in Chemistry," *Journal of Innovations in Teaching and Learning*, vol. 1, no. 1, pp. 4–9, 2021, doi: 10.12691/jitl-1-1-2.