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Association between pre-service science teachers' self-efficacy beliefs and their confidence in physics content

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Abstract: This exploratory study examined the relationship between the knowledge of selected physics concepts from the South African National Senior Certificate curriculum and the self-efficacy beliefs of preservice science teachers. Forty-one preservice physical science teachers between the ages of 16 and 30 enrolled in a higher education institution to earn a Bachelor of Education degree made up the participants. Of these, 56.1% were female and 43.9% were male. Every respondent was a recent high school graduate from South Africa enrolled in a second-year university course on basic physical science. The preservice teachers completed the Science Teaching Efficacy Belief Instrument (STEBI-B) and a teaching confidence ranking scale. A confidence ranking for teaching topics from a typical high school science curriculum was determined by analyzing the data. According to the data analysis, preservice teachers are confident and self-sufficient enough to teach science concepts.

Keywords: Belief; confidence; pre-service teachers; curriculum.

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INTRODUCTION

Teachers are essential figures in education, tasked with equipping learners with the necessary skills and knowledge to become competent and educated persons. Consequently, pre-service teachers should receive comprehensive training throughout their educational preparation. Teachers' acquisition of knowledge and skills during their studies can have both advantageous and detrimental impacts on their future professional trajectories. Identifying the aspects that contribute to the early development of teaching professionals and developing practical solutions can significantly alter the influence they have on the field. Prior research has indicated that teacher efficacy is associated with student achievement (Tschannen-Moran & Hoy, 2001), student motivation (Midgley et al., 1989; Woolfolk-Hoy, 2000; Lewandowski, 2005), serves as the basis for teacher motivation (Aydin & Boz, 2010), and influences classroom management strategies (Ashton & Webb, 1986). Several factors impact student achievement, including teacher qualities such as experience and qualifications (Omolara, 2008). A teacher's quality is crucial because it dramatically affects students' progress. Miles and Stapleton (1998) concur with Omolara (2008) that competent and well-trained teachers are the main factor influencing academic achievement.

Concerns regarding the need for high-quality teacher training to ensure high-quality education are shared by the public and the authorities overseeing the South African educational system. There have been

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several changes to primary education since 1994. Because of the apartheid-era fragmentation and racial and ethnic segregation of the South African education system, these adjustments were judged necessary. It took a great deal of work for South Africa to create a single national ministry of education to serve all South Africans after the country gained independence in 1994 and was placed under new leadership. The National Education Department (NED) combined the formerly segregated education divisions based on race.

The Department of National Education provided a framework for reforming the education sector in its White Paper 1 on Education and Training (DNE, 1994). De-racialization, new institutions and curricula, new standards and norms, and new legislation demonstrated political development and action. Our dynamic world is characterized by rapid, varied, and highly unpredictable change. The planet changes dramatically due to urbanization, globalization, and Westernization (Anil, 2014). Teachers faced demands and challenges due to changes in curricula, teaching methods, and educational policies (Blignaut, 2008; Taole, 2013). Clement and Vandenberge (2000) have reported that despite the assumption made by curriculum changes, research has shown that pre-service teachers need to be more prepared to teach.

Teaching is a skill that relies on the instructor's passion, commitment, and devotion to the subject matter (Kumari & Dhal, 2020). Self-efficacy, also referred to as confidence, is a highly influential psychological concept that has been embraced by positive psychology. Self-efficacy refers to the confident and positive belief in our ability to complete a task and get a favorable result. Research has shown that self-efficacy and learner and teacher preparedness are correlated. Self-efficacy is a significant predictor of teacher effort and persistence (Emmer & Hickman, 1991), effective classroom management (Schunk & Pajares, 2002), and instructional effectiveness (Ashton & Webb, 1986). Self-efficacy beliefs are "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances" (Bandura, 1986). As a function of their gender, departmental satisfaction, and academic achievement, prospective teachers' levels of self-efficacy regarding values education vary significantly (Çetin, 2014). In other words, self-efficacy is the belief in one's ability to accomplish desired outcomes and the evaluation of one's ability to handle challenging situations.

Pre-service teachers are negatively impacted by these changes, which historically have roots in the Department of Basic Education's introduction and implementation of similar changes. A portion of these aspiring educators enrol in teacher education programs, with physics and physical science being one of their subjects. Some pre-service teachers did not intend to become teachers initially, while others are studying to become teachers due to a scholarship provided by Funza Lushaka (a bursary program for students pursuing teacher education). Therefore, it is essential to ensure that pre-service teachers are capable and self-assured enough to take on the demands of classroom management in addition to the difficulties of dealing with subject knowledge and pedagogy/teaching. Therefore, in order to teach physical science, pre-service teachers need to be well-prepared. In their 2002 study, Darling-Hammond, Chung, and Frelow (2002) underlined the importance of preparation for teacher preparation programs. They found a strong correlation between

teachers' opinions of their overall level of preparedness and their assurance that they can connect with every student, address classroom issues, and positively impact students' lives.

Exposure to pertinent knowledge and skills is necessary to develop work confidence (Darling-Hammond & Osher, 2020). In order to incorporate the students' varied cultural backgrounds into their classroom experiences, teachers must also possess the necessary skills (Alismail, 2016). Teachers with a higher enthusiasm and admiration for science are generally more driven to teach the subject, share their passion with students, and foster the preservation of students' innate curiosity. The attitude of teachers towards science significantly impacts pupils' attitude towards science.

The literature highlights several qualities, including an in-depth understanding of pedagogical content, improved problem-solving techniques, adaptability to diverse learners, decision-making, awareness of classroom events, sensitivity to context, and respect for students (Shulman, 1987). Numerous studies emphasize the value of teachers' knowledge and stress the need for pre-service teachers to incorporate experiential and practical knowledge into the classroom in addition to academic knowledge. Furthermore, studies show that variations in learning experiences during the preparation of teachers are linked to variations in student performance: teachers from nations with high PISA and TIMSS rankings typically have greater access to content, pedagogy, and general pedagogy (OECD, 2017).

According to research in developmental science, children who have experienced adversity "may be more pliable and stand to gain the most from supportive, enriched environmental supports and treatments" (Cantor et al., 2018). This is consistent with those findings. The cornerstone of confidence at work is having the skills and knowledge necessary for the role. During pre-service teacher education, it is critical to track the development of teacher self-efficacy. According to Pendergast, Garvis, and Keogh (2011), teachers with high self-efficacy tend to be more resilient during the teaching process and put forth more effort to help their students reach their full potential. High self-efficacy can have both positive and harmful impacts on motivation. Individuals who possess a high level of self-efficacy tend to exhibit a greater inclination to exert effort in order to accomplish a given task. Furthermore, they are more inclined to persevere longer in their endeavors than individuals with low self-efficacy.

Low self-efficacy can have a detrimental impact by inducing a condition known as learned helplessness (Kumari & Dhal, 2020). A high degree of self-efficacy facilitates applying professional skills and knowledge effectively. As a result, successful educators seemed to be happier in their jobs and were more likely to stick with teaching (Çapa, 2005). The mechanism through which self-efficacy affects performance at work is called self-regulation. People who are proactive and introspective may be the cause of this. According to McDonnough, McKelvey, Baski, and Lewis (2004), pre-service teachers need educational experiences that expand their subject-matter expertise in excellent teaching techniques. Numerous issues about self-confidence have been identified in science education. One aspect is that educators have a restricted knowledge base regarding scientific subjects (Wu & Chang, 2006). Many educators find it challenging to

implement technology in the classroom (Hakverdi et al., 2007) and to conduct science experiments and other hands-on activities (Muwanga-Zake, 2001), even though a large number of technology-based teaching resources and methods successfully engage students and develop their skills.

Impact of Pre-service Science Teacher Education/Preparation and Work Environment

Science is a crucial secondary subject because it broadens the content knowledge of both teachers and students by helping them understand basic scientific principles. Students' general and subject-specific academic knowledge is collectively called content knowledge. However, educators needed help understanding some scientific ideas for a while. They also found it challenging to teach some scientific concepts. If teachers need help understanding these ideas, they will be correctly conveyed to students, resulting in the spread of different ideas. In order to help students develop useful cognitive maps, relate one concept to another, and address alternative viewpoints, teachers teaching science concepts today need a thorough and flexible understanding of the subject matter (Chavan, 2013).

Teachers must understand how concepts relate to one another within and between disciplines. This kind of understanding could be the basis for pedagogical content knowledge, which helps teachers understand students' conceptual challenges and make concepts understandable to others. Tepner and Dollny (2012) discovered that the level of chemistry teachers' content understanding differs depending on the specific type of school they are employed in. Previous research has shown that professional development programs can improve teachers' understanding of science topics and increase their self-assurance in teaching science (McDonnough et al., 2004). Professional instructors require growth programs, which may result in some teachers needing more material understanding despite their qualifications. This will lead to diminished self-efficacy and a deficiency in confidence when teaching specific topics. Numerous countries, including South Africa, face significant issues regarding teacher credentials, supply, and training (Monk, 2007). This study aims to investigate the school's geographical location and pre-service teachers' self-assurance and competence in teaching physical science.

Research Questions

In this study, the following research questions were investigated:

1. How confident and capable do pre-service teachers feel about their ability to teach physical science?
2. In what ways do the demographic location and type of school attended of pre-service teachers affect their content knowledge?

Theoretical Framework

Bandura's self-efficacy theory forms the primary basis of this study's theoretical framework. Self-efficacy is the belief in one's ability to finish a task, according to Bandura (1997). According to Bandura (1994, 1997), self-efficacy is influenced by four key elements. One's feeling of self-efficacy is impacted by how they handle the situation. This happens when someone tries something and succeeds. This suggests that the person has gotten the hang of the problem. A person's self-efficacy rises as a result of overcoming the

experience, according to Bandura (1994). This is comparable to the current study, where pre-service teachers were anticipated to feel confident in their capacity to teach physics concepts because they had been trained on them. Physics lecturers assisted pre-service teachers in communicating physics ideas and experiences. This aligns with Bandura's (1997) claim that providing professional development opportunities, training, and support helps students apply self-efficacy theory. The second factor that affects self-efficacy is indirect experience. It entails analyzing and drawing lessons from the successes and mistakes of others. One's sense of self-efficacy can be increased by witnessing someone else go through something they would like to go through (Bandura, 1994). This is relevant to a study wherein pre-service teachers observed their physics lecturers effectively imparting physics concepts. Pre-service teachers increased their sense of self-efficacy by gaining knowledge from the experiences of the lecturers and teachers they observed.

METHOD

Research Design

The study used a non-experimental, exploratory quantitative research design. The researcher used the Science Teaching Efficacy Belief Instrument (STEBI-B) along with some self-constructed questions as a data collection tool to assess pre-service teachers' confidence and preparedness in their content knowledge and teaching effectiveness in selected science topics.

Participants

Forty-one (41) pre-service teachers from a public university in South Africa participated in this study; of them, 43.9 percent were men and 56.1 percent were women between the ages of 16 and 30. Following their secondary school graduation, all of the participants are enrolled in a university to pursue a Bachelor of Education with a physical science concentration**.**

Table 1. Background Variables for the Participants (N=41)

	Description	Frequency	Percent
Gender	*Female*	23	56.10
	Male	18	43.90
Total		41	100
Age	15-20	22	53.66
	21-25	18	43.90
	26-30	1	2.44
Total		41	100

Physical Science Pre-service Teaching Experience of Respondents

The respondents' experiences teaching physical science ranged from none at all to at least a year. Pre-service teachers' self-confidence may be impacted by how long they have taught science. Only four respondents had one to two years of pre-service teaching experience, making up the lowest population category of 9.8%. The largest population category comprised 90.2%, with 37 respondents having three to six months of experience teaching science. It's noteworthy that the COVID-19 pandemic kept these second-year pre-service teachers from finishing their practicum classes on schedule. It is noteworthy that 28 (68.3%) of

the pre-service teachers taught both physics and chemistry, while 4 (9.8%) of the pre-service teachers only taught chemistry. As a result, 34 (82.93%) of the pre-service teachers taught physics during the pre-service practice teaching. During their teacher preparation, 35 (85.4%) pre-service students stated that they majored in physical science. According to their qualification registration, 21.95% of pre-service teachers were not given the chance to teach chemistry. In physics, similar findings were observed: 12.2% of pre-service teachers did not instruct any physics lessons during their practicum. The differences can be ascribed to the sections of the syllabus specific to each school as well as the grades pre-service teachers received at the time.

The Type of School

The types of schools in each of the six participating provinces are listed in Table 2. The categories for school types are private, public, and rural schools. Table 2 shows that public schools made up 95.1% of the schools that took part in the study across the six provinces, with private schools coming in second at 4.9% and farm schools in last place at 0.0%. It is noteworthy that the majority of schools from which survey participants were drawn are public institutions, with only two private schools located in the provinces.

Table 2. Respondents by school type (N=41)

	Description	Frequency	Percent
Type of School	Private	2	4.90
	Public	39	95.10
	Farm	0	0.0
Total		41	100

The Geographical Location of Schools Practice Teaching was done

Table 3 provides information regarding the geographic location of the schools.

Table 3. Respondents by the geographical location of the school they attended/did their practical teaching (N=41)

	Description	Frequency	Percent
Geographical location of the school	Other	1	2.40
	Rural	27	65.70
	Semi-Urban	9	22.00
	Urban (Town)	3	7.30
	Urban (Town), Semi-Urban	1	2.40
Total		41	100

Schools may be located in rural, semi-urban, or urban areas, according to this study. Table 3 indicates that sixty-seven percent of pre-service teachers worked in rural schools; these schools are primarily located in the five provinces of the respondents, with a few in Gauteng Province. Semi-urban school areas rated second (22.0 %), former Model C schools in cities ranked third (7.3 %), semi-urban/urban ranked fourth (2.4 %), and others (2.4 %) ranked fifth (2.4 %). Nearly (31.7%) of the schools are located in townships.

Research Instruments

Scientific Teaching Outcome Expectancy (STOE) and Personal Science Teaching Efficacy (PSTE) are two of the 23-item Likert scale subscales used to measure the self-efficacy of science teachers. The STOE and PSTE sub-scales, which are derived from the STEBI-B, were created by Enochs and Riggs in 1990 and are frequently used to assess the efficacy views of pre-service and in-service teachers when it comes to teaching science. The STEBI-B is a Likert scale with five points, from one for "strongly disagree" to five for "strongly agree." Enoch and Riggs state that while the personal science teaching efficacy beliefs relate to the degree to which science teachers can positively affect students' achievement, the science teaching outcome expectancy reflects science teachers' beliefs that effective teaching can influence student learning.

Data analysis

Descriptive statistics like percentages, means, and standard deviation were used to analyze the data related to the study topics. However, using the Chi-Square value, the hypotheses were evaluated at the significant level of a p-value of 0.05.

RESULTS AND DISCUSSION

Confidence of Respondents in Teaching Selected Physics Concepts

Table 4 shows that most pre-service teachers had confidence in their ability to teach a few specific physics concepts from the Curriculum and Assessment Policy Statement (CAPS). Table 4 shows that teachers were least confident when teaching Waves, Sound, and Light, which includes geometrical optics and 2D wavelengths, and most confident when teaching mechanics, electricity, and electromagnetic (standard curriculum concepts numbered 1 to 7).

Table 4. Pre-service teachers' confidence in teaching selected physics concepts (N=41)

Knowledge	Concepts	Mean	SD	Rank Order	Standard Curriculum (Yes/No
Mechanics	Vectors in 2D	2.804878	0.459321	2	Yes
	Newton's Law and Application	2.902439	0.300406	1	Yes
	Momentum and Impulse	2.902439	0.300406	1	Yes
	Vertical Projectile Motion in 1D	2.634146	0.581210	3	Yes
	Work, Energy and power	2.48780	0.630524	7	Yes
0Waves, Sound and Light	Geographical Optics	2	0.741620	8	Yes
	2D Wavefronts	1.853659	0.654254	9	Yes
	Doppler Effect	2.560976	0.634381	5	Yes
Electricity and Magnetism	Electrostatic	2.634146	0.581210	3	Yes
	Electromagnetism	2.536585	0.36300	6	Yes
	Electricity	2.609756	0.627616	4	Yes
Average Mean and SD		2.498891	0.558841		

Influences of the Type of School Attended and Geometrical Location

A significant association between the respondents' type of school attended (public school) and confidence to teach was observed for vectors in two dimensions with (frequency = 34, 82.9%), p = 0.000 <0.05; Newton's laws and their application with (frequency = 37, 90.2%), p = 0.02 < 0.05; 3D wavefronts [(frequency = 23, 56.1% slightly confident) and (frequency = 5, 12.2% confident)], p = 0.05 for example. Constructions are impacted by the results according to the type of school attended: (physics component and STEBI-B). This relates to: (two-dimensional vectors, Newton's laws and their applications, and three-dimensional wavefronts; I am aware of the procedures required to teach Physical Science concepts effectively; if students are not meeting expectations in Physical Science, it is most likely because science is not being taught well; I am familiar enough with Physical Science concepts to be able to effectively teach Secondary (FET) science; and I can usually respond to students' Physical Science inquiries.) Considering that each p-value was less than < 0.05.

Table 5. Respondents' PSTE and STOE per type of school attended.

PSTE		Privat (Freq.	%	Public (Freq.)	%	Total	%	Chi-Square value		p-Value
I know the steps necessary to teach Physical Science concepts effectively.	Agree	0	0.0	25	61.0	25	61.0	5.979[a]	2	0.050
I understand Physical Science concepts well enough to be effective in teaching secondary (FET) science.	Agree	0	0.0	18	43.9	18	43.9	9.481[a]	3	0.024
I will typically be able to answer learners' Physical Science questions.	Strongly Agree	0	0.0	16	39.0	16	39.0	12.98[a]	2	0.002
If learners are under-achieving in Physical Science, it is most likely due to ineffective science teaching.	Agree	0	0.0	22	53.7	22	53.7	9.481[a]	4	0.050

For vectors in two dimensions (frequency = 34, 82.9%), p = 0.007 <0.05; Newton's laws and their application (frequency = 37, 90.2%), p = 0.00 <0.05; momentum and impulse (frequency = 37, 90.2%), p = 0.015 <0.05; and electromagnetic (frequency = 25, 61.0%), p = 0.043 <0.05), there was a significant correlation found between the respondents' confidence to teach and the school's geographic location (rural school). The construction (physics component and STEBI-B) results are influenced by the location of the school you attended. This relates to: (For example, Newton's laws and how they are applied, momentum and impulse, and electromagnetic; when teaching physical science, I will typically teach it in an ineffective manner and welcome questions from the students.) Given that each p-value was less than 0.05

Table 6. Respondents' PSTE per geographical location

PSTE		Other (Freq.)	%	Rural (Freq.)	%	Semi-Urban (Freq.)	%	Urban-Town (Freq.)	%	Urban (Town-semi-Urban) (Freq.)	%	Total	%	Chi-Square value	df	P-Value
I will generally teach Physical science in-effectively	Strongly Agree	1	2.4	11	26.8	6	14.6	1	2.4	0	0.0	19	46.3	26.950[a]	16	0.042
When teaching Physical Science, I will usually welcome learner question	Strongly Agree	1	2.4	20	48.4	9	22.0	0	0.0	1	2.4	31	75.6	23.079[a]	12	0.027

There is a correlation between the respondents' geographic location of the school you attended and their statement, "I will generally teach Physical Science ineffectively." P-value = 0.042 <0.05, 26.8% for the rural location firmly I disagree that "I will generally teach Physical Science ineffectively" is a STEBI-B construct. "When teaching Physical Science, I will usually welcome learner questions" and the location of the school you attended are related. P-value = 0.027 <0.05, 48.8% of rural areas strongly concur with the STEBI-B construct "When teaching Physical Science, I will usually welcome learner questions". The construct STEBI-B is impacted by the location of the school you attended. "When teaching physical science, I will typically do so in an ineffective manner and welcome questions from the students."Given that each p-value was less than 0.05.

Influence of Teaching Efficacy Beliefs

Teachers can exert either a beneficial or detrimental influence on students' academic achievements, as well as their social and personal development, during their educational journey. Teachers with a strong sense of self-efficacy play a crucial role in providing high-quality education. The level of self-efficacy beliefs can have both positive and negative effects on teacher behaviors, including their level of effort, feedback provision, choice of teaching methods and techniques, and use of teaching materials (Enochs & Riggs, 1990; Gibson & Dembo, 1984). Efficacy, which refers to a teacher's level of confidence in their abilities, can be greatly influenced by previous experiences or the prevailing culture in their current school (Kahveci, 2023). For instance, an unfavorable classroom experience or a hostile work atmosphere can rapidly erode a teacher's self-confidence. It is noteworthy that observing learners develop and working in a cooperative setting can enhance a teacher's confidence in their competence and enhance their performance. Allinder (1994) discovered that instructors with strong teaching efficacy views were inclined to utilize diverse teaching strategies in their classrooms. The results of the study in which pre-service teachers' efficacy beliefs were investigated to some variables revealed that they were confident and self-sufficient enough to teach science concepts. Details about the Science Teaching Outcome Expectancy and Teachers' Personal Science Teaching

Efficaciousness by School Type and Geography are given in Tables 5 and 6. Using a chi-square statistic, significant correlations (p-values < 0.05) were found between PSTE scores and school type and location. But STOE was marginally less than PSTE. Location and STOE scores did not correlate as per the study's findings, pre-service teachers' confidence to teach the majority of the chosen physics concepts is more significantly impacted by the kind of school they attended than by where their schools are located. It is difficult for pre-service teachers to positively endorse the items on the STOE scale, according to prior research (Cantrell & Moore, 2003; Knaggs & Sondergeld, 2015; Menon & Sadler, 2016). Their unfamiliarity with educational environments and their geographical location have been blamed for this problem.

Nysschen (2022) findings are consistent with the pre-service teachers' apparent confidence in their comprehension of the material, despite the students' performance showing no appreciable improvement. The small group size that limited analysis and the absence of assessments with the pre-service teachers regarding the physics concepts are two limitations of this study. The participants evaluated their level of confidence and effectiveness in communicating the selected concepts. Additionally ignored was pedagogical content knowledge. The term "pedagogic content knowledge" refers to the comprehension of the elements that affect a subject's learning curve, such as the presumptions and ideas that students of various ages and backgrounds bring to the process of comprehending the most frequently taught lessons and subjects, as per Shulman (1987), the writer. Lack of pedagogical knowledge may be linked to pre-service teachers' lower levels of self-efficacy and teaching confidence.

The results of these and comparable research are thought to have potential value in enhancing self confidence for teacher training. Furthermore, it is anticipated that the findings of the study could provide valuable insights for future research endeavors.

CONCLUSION

The type of institution and location of the school where pre-service teachers receive their education are two factors that impact how much content they know. In terms of pre-service teachers' ability to teach, the PSTE had a stronger impact than the STOE. Thus, the level, breadth, and quality of pre-service teachers' preparation have an impact on their sense of self-efficacy and confidence as educators. The findings from this and comparable research are thought to be valuable for the training of pre-service teachers. The study results are expected to provide insights for future research. However, as a result of a low enrollment of pre-service teachers for this qualification, the scope of this study was restricted to only 41 participants.

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number of reviewers. The recommended reviewers can be listed at the end page after references because the review is conducted by a double-blind method.

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