e-ISSN: 2789-5661
2024: Vol 4, pp 1-19. https://doi.org/10.38140/ijss-2024.vol4.25
Interdisciplinary Journal of Sociality Studies

The Synergy Amongst Factors Influencing Pre-service Science Teachers' Perceptions of Inclusive Education

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EDITORIAL INFORMATION
Received: 08 August 2024
Revised: 10 November 2024
Accepted: 04 December 2024
Published: 31 December 2024

DOI: 10.38140/ijss-2024.vol4.25

Abstract: This study explores the synergy among factors influencing Ghanaian pre-service science teachers' perceptions of inclusive education. The factors considered were desirable outcomes (DO) of inclusive education, implementation of inclusivity (IM), and willingness to adopt inclusivity (W). The study employed the explanatory sequential variant of the mixed-methods research design, using 503 pre-service science teachers from the Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development. The instruments used were a five-point Likert scale questionnaire and a semi-structured interview guide. Quantitative data were analysed using path analysis through structural equation modelling (SEM) employing Analysis of Moment Structures (AMOS) version 23. Qualitative data from the interviews were, however, analysed using thematic analysis. Quantitative findings revealed that the implementation of inclusive education significantly predicted Ghanaian pre-service science teachers' perceptions of inclusive education. However, willingness to adopt inclusivity and desirable outcomes of inclusive education were not significant contributors. Qualitative findings, however, revealed that practical application and hands-on experience, availability of resources and support, self-efficacy, classroom diversity and time constraints, and the need for further training might have explained the non-significant influence of desirable outcomes of inclusive education and willingness to adopt inclusivity on the perceptions of Ghanaian pre-service science teachers regarding inclusive education. It was therefore recommended, among other things, that teacher training institutions in Ghana should prioritise experiential learning opportunities, such as intensive inclusive teaching practicums, classroom simulations, and mentorship programmes, which can bridge the gap between theoretical instruction and practical application.

Keywords: Inclusive education**,** teachers' perceptions, pre-service teachers, science teachers.

1. Introduction

The Ghanaian Government's desire to provide all learners with quality education (Ministry of Education, 2015) can be facilitated through the medium of inclusive education (IE). This approach ensures access to learning for all learners (Ministry of Education, 2015; United Nations, 2016). The guiding principle of IE is that schools should accommodate all learners, regardless of their abilities, disabilities, socio-economic status, gender, ethnicity, or any other background (Arthur & Chen, 2023; Guliya et al., 2023). Therefore, IE aims to enable all students to reach their full potential by integrating them into a single classroom and community, irrespective of their areas of strength and weakness (Singh, 2014).

Currently, as IE has been accepted by many countries, more students with diverse educational needs can learn alongside their peers in mainstream schools (Leijen et al., 2021; Miller, 2020). This shift calls for specialised training for teachers to manage such situations effectively. However, the lack of preparedness for inclusive teaching may stem from gaps in teachers' knowledge about pedagogies and other aspects of inclusion. Literature, such as Massouti (2021) and Wray et al. (2022), highlights

How to cite this article:
Appiah-Twumasi, E., Ofori, P.A., Osei-Owusu, B., & Twum Ampofo, E. (2024). The synergy amongst factors influencing pre-service science teachers' perceptions of inclusive education. *Interdisciplinary Journal of Sociality Studies*, *4*, 1–19. https://doi.org/10.38140/ijss-2024.vol4.25

that high-quality training for teachers is critical for inclusive teaching. Accordingly, to successfully implement IE, the United Nations Educational, Scientific and Cultural Organisation (UNESCO) policy recommends that the educational system design professional learning opportunities and teacher education to dispel the myth that certain students cannot learn mainstream subjects in inclusive classrooms or are uneducable (UNESCO, 2020). As a result, nations worldwide, since the introduction of IE, have worked to modify their pre-service and in-service teacher training programmes to equip teachers with the educational tools necessary to adopt and utilise IE. However, Almalky and Alwahbi (2023) reiterate UNESCO's (2020) observation that teaching in inclusive contexts is not sufficiently considered in teacher development programmes across many nations. Similarly, Makoelle and Burmistrova (2021) asserted that numerous teacher training institutes have yet to fully embrace the transformation of teacher education necessary to facilitate the shift towards IE.

In Ghana, since the introduction of IE in 2015, efforts have been made to train both in-service and pre-service teachers in inclusive pedagogical approaches to facilitate the effective implementation of IE. In this regard, Ghana's Objective 3 for inclusive education emphasises the promotion of a well-informed and qualified human resource framework to enhance the quality of IE (Ministry of Education, 2015). To achieve this policy goal, pre-service science teachers must be adequately prepared in both theory and practice to implement IE in mainstream schools in Ghana. Buabeng et al. (2020) express that the education of pre-service teachers provides them with professional preparation, pedagogical training, subject content knowledge, and classroom readiness. They further add that the education of pre-service teachers also equips them to understand the concepts of diverse learners, professional ethical standards, continuous improvement, and lifelong learning.

In line with the preparations for pre-service teachers for IE, the literature highlights several crucial aspects that must be considered. For instance, Makoelle and Burmistrova (2021) emphasise that methodological training, along with the abilities and skills of pre-service teachers, as well as the values and attitudes towards students with special educational needs and disabilities, should be integral to their training for successful IE.

Despite the factors discussed, it is important to acknowledge that factors influencing teachers' perceptions of IE cannot be overstated. For example, studies revealed that teacher professional development, resource availability, and institutional support are significant factors influencing teachers' perceptions of IE (Dalamitrou et al., 2024; Mashwama & Omodan, 2024). According to Zhang et al. (2024), gender, age, the role of the class teacher, the role of the administrator, the subject taught, the type of disability of students, school support resources, and job demands can all potentially influence teachers' perceptions of inclusive education. Similarly, Deku and Vanderpuye (2017) found that age, teaching experience, and professional qualifications influenced teachers' perceptions of inclusive schools and were significantly associated with perceptions of inclusive teaching. However, these studies, among others, often focus on in-service teachers.

Since pre-service teachers may lack classroom experience to implement IE, their perceptions and concerns may differ from those of in-service teachers, creating a gap in understanding the factors influencing these perceptions. As a result, this study considers it appropriate to examine the interplay among pre-service teachers' knowledge of the desired outcomes of IE, their willingness to implement IE, their readiness to implement IE, and their perceptions of inclusive teaching, an area not thoroughly explored in the literature. Furthermore, while many studies have investigated IE in a general context, few have addressed it within the specific context of science education. This study, therefore, expands the literature by providing insights into the factors that influence pre-service science teachers' perceptions of inclusive teaching within STEM fields, where instructional and practical challenges may differ from those in other fields of study. Specifically, the study sought to answer the following research questions:

- Does the knowledge of pre-service science teachers regarding the desirable outcomes of inclusive education significantly influence their perceptions of inclusive education?
- Does the willingness of pre-service science teachers to implement inclusive teaching significantly influence their perceptions of inclusive education?
- Does the readiness of pre-service science teachers to implement inclusive teaching have a significant influence on their perceptions of inclusive education?
- What are the perceptions of pre-service science teachers regarding the variance among desirable outcomes, implementation, and willingness to implement inclusivity?

2. Theoretical Framework of the Study

This study is supported by the theory of planned behaviour (TPB), proposed by Ajzen (1991). TPB builds on the premise that an individual's behaviour is driven by three key components, attitudes, subjective norms, and perceived behavioural control, which collectively shape behavioural intentions and, ultimately, actions (Ajzen, 2020). Central to the TPB is the concept of attitude, which, according to Ajzen (2020), refers to an individual's positive or negative evaluations of behaviour. In this study, attitude manifests as pre-service science teachers' perceptions of inclusive education. Ajzen (2020) posits that favourable attitudes towards a behaviour increase the likelihood of forming strong intentions to engage in that behaviour. For pre-service science teachers, their willingness to implement inclusive teaching strategies may depend on their perceptions of its desirability and efficacy in addressing diverse learner needs. This highlights the important role of targeted teacher education programmes in fostering positive attitudes and perceptions towards inclusive education.

Another important component of TPB is perceived behavioural control (PBC), which reflects an individual's belief in their ability to execute a particular behaviour, even in the face of challenges (Ajzen & Schmidt, 2020). In this study, PBC aligns with pre-service science teachers' readiness to implement inclusive education, encompassing their confidence in designing and delivering inclusive learning experiences. Ajzen (2020) emphasises that PBC not only influences intentions but also directly affects behaviour, especially when individuals encounter obstacles. For pre-service science teachers, factors such as their exposure to inclusive pedagogical strategies and practical teaching experiences significantly impact their sense of control and readiness (Brussino, 2021; Chow, 2024). Understanding these influences is essential for preparing science teachers who are not only willing but also capable of translating inclusive principles into practice.

Behavioural intention, a central construct in TPB, bridges attitudes, subjective norms, and PBC to actual behaviour (Ajzen, 2020). For pre-service science teachers, the willingness to embrace inclusive education represents their intentions to implement it. Ajzen (2020) asserts that strong behavioural intentions, shaped by positive attitudes and high perceived control, are reliable predictors of successful behaviour execution. This aligns with the study's aim to explore how the desirable outcomes of inclusive education, pre-service science teachers' willingness and readiness, and their eventual practice of inclusive science teaching influence their perceptions, as conceptualised in Figure 1.

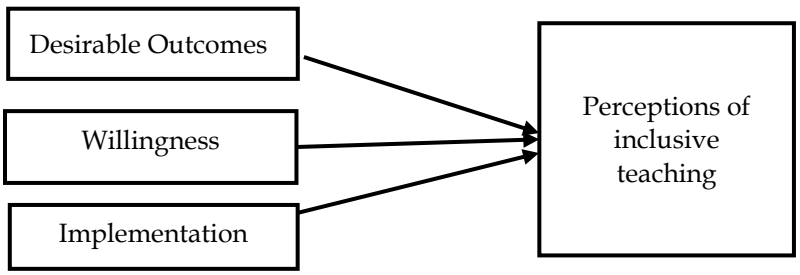

Figure 1: *Conceptual framework of the study*

2.1 Desirable outcomes of inclusive education

Desirable outcomes of inclusive education encompass the broad benefits that arise from effectively integrating diverse learners into unified classrooms (Haug, 2017). In this study, these desirable outcomes can be extended to the professional development of pre-service teachers. Exposure to inclusive practices during their training can enhance their pedagogical skills and adaptability in addressing diverse learning needs (Brussino, 2021). When pre-service teachers understand and witness the positive impacts of inclusivity, they are more likely to adopt similar strategies in their future classrooms (Massouti, 2021). Ultimately, these outcomes serve as a motivational factor for pre-service teachers, driving their commitment to embracing inclusivity in their professional practice.

2.2 Willingness to adopt inclusivity

Willingness reflects pre-service teachers' inclination to embrace inclusive practices within their future classrooms. According to Dignath et al. (2022), teachers' willingness to adopt inclusive strategies is significantly affected by their beliefs and attitudes towards diversity. For instance, teachers with a positive attitude towards inclusive education are more likely to engage with and adapt their teaching methods to meet the needs of all students (Charitaki et al., 2022). Furthermore, pre-service teachers' willingness to implement inclusive education is also influenced by their experiences and exposure to inclusive practices during their training. Brussino (2021) highlights those practical experiences, such as field placements in inclusive settings, significantly enhance their confidence and readiness to incorporate inclusivity into their teaching. This experiential learning allows pre-service teachers to witness firsthand the positive outcomes of inclusive education, thereby reinforcing their willingness to adopt such practices.

2.3 Implementation of inclusive education

The implementation of inclusive education is a vital factor that determines how effectively pre-service teachers can translate their perceptions and willingness into practice. Successful implementation hinges on several elements, including the availability of resources (Andrews et al., 2021), supportive policies (Salmi & D'Addio, 2021), and comprehensive training within teacher education programmes (Mpu & Adu, 2021). Studies conducted by Mukelabai et al. (2021) and Alhammadi (2024) suggest that pre-service teachers often feel unprepared to implement inclusive strategies due to inadequate exposure to practical teaching experiences that address the complexities of diverse learning needs. This lack of preparation can lead to hesitance or reluctance when faced with the challenges of designing and delivering inclusive lessons that accommodate all learners.

2.4 Perceptions of Pre-service Teachers of Inclusive Education

The perceptions of pre-service teachers about inclusive education help to appreciate and recognise how they understand and approach inclusive education. These perceptions are shaped by a number of factors, including personal beliefs, educational experiences, and societal attitudes toward diversity and inclusion (Massouti, 2021; Yu & Cho, 2022). For instance, Schwab et al. (2024) revealed that pre-service teachers who had received comprehensive training on inclusive education tend to hold more positive perceptions, seeing inclusivity as beneficial not only for students with disabilities but also for the entire classroom community. Conversely, those with limited exposure to inclusive strategies may perceive it as an added burden, leading to apprehension and reluctance to adopt inclusive methods in their classrooms. These perceptions not only reflect the readiness and willingness of teachers to embrace inclusivity but also impact their confidence and ability to implement inclusive practices effectively. Educators who embrace inclusive values and have positive perceptions of diversity are more likely to employ inclusive pedagogies, create supportive learning environments, and advocate for the needs of all students (Dewsbury & Brame, 2019). Consequently, the perceptions of pre-service junior high science teachers may play a crucial role in shaping the inclusivity of educational environments.

3. Methodology

This study, which occurred between 2023 and 2024, adopted an explanatory sequential design that follows pragmatism as a theoretical assumption. Guided by the explanatory sequential mixed-method design, quantitative data were first collected and analysed, followed by qualitative data collection and analysis, where the qualitative results were used to explain the quantitative results. The quantitative approach was well suited to obtain reliable and objective information from participants using a questionnaire and to clearly understand the trends and patterns of participant perceptions in a descriptive and inferential manner regarding the implementation of inclusive education.

The qualitative aspect of the study also relied on narrative inquiry, a qualitative methodology that primarily studies and understands the narrative experiences of the participants. In particular, the qualitative narrative used in this study helped to better examine the respondents' perceptions regarding the impact of implementation, desirable outcomes, and willingness on the participants' perceptions of inclusive teaching.

3.1 Population and sample

The target population for the study comprised all pre-service science teachers pursuing a Bachelor of Education in Junior High at the Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development (AAMUSTED). These pre-service science teachers had taken courses such as inclusive school-based inquiry, differentiated planning, multimedia development, and guidance and counselling alongside eight semesters of experiential learning known as supported teaching in schools—a type of practicum. These curriculum interventions prepared participants to implement inclusive education. In line with these interventions, the study authors sought to examine the factors that explain their perceptions of inclusive education in the teaching and learning of science. Thus, the total population consisted of 503 pre-service science teachers, with 250 in the 2022/2023 academic year and 253 in the 2023/2024 academic year.

For the quantitative phase of the study, total population sampling was used to ensure the inclusion of all pre-service science teachers. The 2022/2023 cohort (n=250) was used to validate the instrument, while the 2023/2024 cohort (n=253) participated in the main study, providing data for structural equation modelling (SEM). The use of total population sampling is justified by the need for a sufficient sample size to enhance the accuracy of SEM analysis. In the qualitative phase, a stratified purposive sampling strategy was employed to achieve gender balance and reflect the study's emphasis on inclusive education. Accordingly, the second cohort (n=253) was stratified based on gender, and participants were purposively selected to represent both male and female pre-service science teachers. Ultimately, 20 participants, consisting of 10 males and 10 females, were interviewed to achieve data saturation.

3.2 Data collection tools instruments

A four-point Likert scale questionnaire, as well as a semi-structured interview guide, were used to collect data from participants. The items on the instruments measured four different constructs under study. The first construct was Desirable Outcomes (DO), which measured outcomes of inclusive education. The second construct was Willingness (W), which assessed pre-service teachers' inclination to adopt inclusivity in their classrooms. The third construct, Implementation (IM), measured pre-service teachers' readiness to practise and design experiences. The final construct measured in this study was pre-service teachers' perceptions of Inclusive Teaching (IT).

This construct assessed how pre-service teachers view and understand the concept of inclusive teaching. All items on the questionnaire were measured using the 4-point Likert scale: "1 - strongly disagree", "2 - disagree", "3 - agree", and "4 - strongly agree." Among the constructs, the DO, W,

and IM components were adapted from Kielblock (2018), while the IT component was adapted from Hunter-Johnson et al. (2014), Paguirigan (2020), and Dewsbury and Brame (2019). Originally, each construct contained ten (10) items, making a total of forty (40) items. The semi-structured interview guide, on the other hand, consisted of four items, which were used to solicit deeper insights from the qualitative sample in a one-on-one format following the quantitative phase.

3.3 Validity and reliability

Content validity was established by first reviewing the literature to identify items that measured the constructs under study for both the questionnaire and interview guide. Subsequently, the instruments were given to two experts in the field of psychology as well as two experts in the field of science education, all from AAMUSTED. The experts were invited to evaluate the quality of each item under each construct and provided feedback on the relevance, clarity, and comprehensiveness of the items. Following their recommendations, some items were reworded to eliminate ambiguity. The originally designed instruments were piloted using the first cohort, that is, the 2022/2023 academic year group (n = 250) of pre-service science teachers from the total population. However, 20 participants from the first cohort were used for the piloting of the interview guide. This activity highlighted minor issues in item clarity and ordering, which were subsequently addressed.

With the interview guide, reliability was ensured through the standardisation of the interview process. Thus, all interviews began with a uniform introduction, and the sequence of questions remained consistent across participants. The responses from the piloted interviews were subjected to inter-coder reliability using Cohen's Kappa, resulting in a value of 0.85, demonstrating strong agreement between coders (O'Connor & Joffe, 2020).

Regarding the questionnaire, the data from the pilot study was subjected to exploratory factor analysis (EFA) using version 23 of the statistical package for social sciences (SPSS) to determine the instrument's factor structure. Examination of the EFA using eigenvalues exceeding 1 (Watkins, 2018) revealed four factors. The four factors identified were the desirable outcome of inclusive education (DO), willingness to practice inclusive education (W), implementation of inclusive education (IM), and perception of inclusive education (IT), with corresponding variances of 15.127%, 14.935%, 14.781%, and 13.794% respectively. Cumulatively, the four factors accounted for 58.638% of the total variance with item loadings between 0.631 and 0.865. Further examination of the results revealed a correlation matrix with coefficients of 0.3 and above for all the items. Also, the Kaiser-Meyer-Olkin (KMO) value was found to be 0.738, exceeding the recommended value of 0.6 (Pallant, 2011), and Bartlett's Test of Sphericity reached statistical significance (p = 0.000), supporting the factorability of the correlation matrix (Pallant, 2011).

Subsequently, confirmatory factor analysis (CFA) was conducted using analysis of moment structures (AMOS) version 23, with the following goodness-of-fit measures: comparative fit index (CFI) > 0.95; Tucker-Lewis's index (TLI) > 0.95; root mean square error of approximation (RMSEA) < 0.06; standardised root means square residual (SRMR) < 0.08 (Hu & Bentler, 1999). The results are presented in Table 1.

Table 1: *Goodness of fit indices of measurement model*

GOF Measure	Result	Recommended threshold	Interpretation
χ^2 [*df*] (sig)	232.043 [129] (p=0.001)	p > 0.05	
χ^2 / *df*	1.799	≤ 3	
GFI	0.956	≥ 0.95	Excellent
AGFI	0.973	≥ 0.95	Excellent
CFI	0.961	≥ 0.95	Excellent
TLI	0.969	≥ 0.95	Excellent

SRMR	0.071	< 0.08	Excellent
RMSEA	0.058	< 0.06	Excellent
P-Close	0.052	> 0.05	Excellent

The fit indices presented in Table 1 indicate that the chi-square model fit was statistically significant (χ^2 = 232.043, df = 129, p = 0.001), suggesting a poor model fit. However, since the chi-square test is sensitive to larger samples (Besnoy et al., 2016), other fit indices (GFI = 0.956, AGFI = 0.973, CFI = 0.961, TLI = 0.969, SRMR = 0.071, RMSEA = 0.058, and P-Close = 0.052) were examined to assess the appropriateness of the items in measuring the respective constructs. The results revealed excellent fit indices, as suggested by Hu and Bentler (1999), indicating that the model fits the data. The measurement model from the CFA is presented in Figure 2.

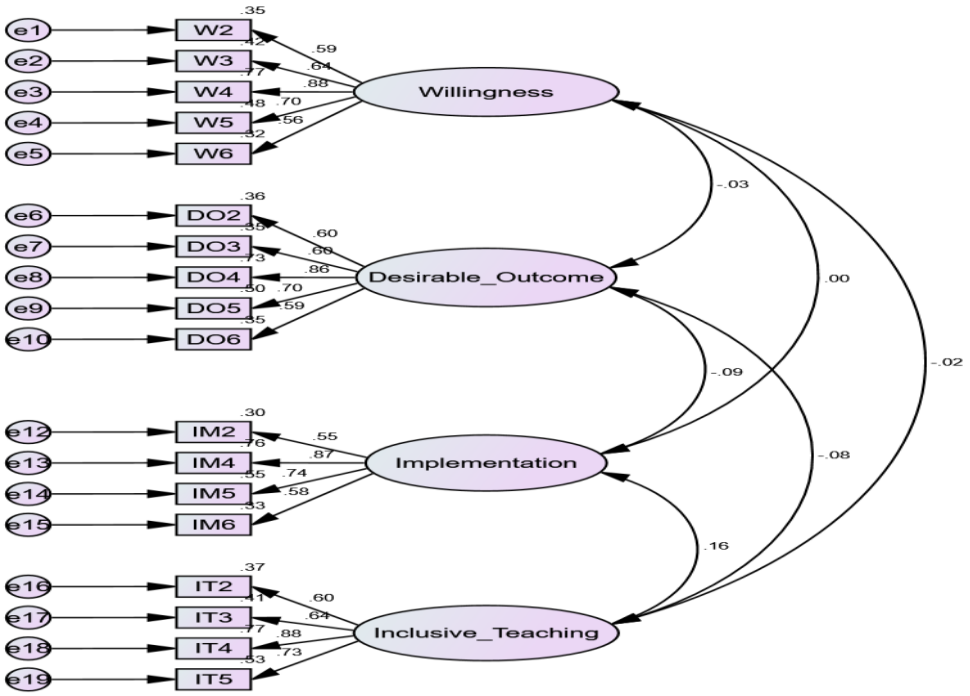

Figure 2: *Measurement model of latent constructs and observed variables*

During the CFA, items which had factor loadings less than 0.50, which is the recommended standard factor loading (Hair et al., 2021), were removed. The resulting standardised factor loadings, which were above 0.50, are presented in Table 2.

Table 2: *Factor loadings, construct validity and reliability*

Item	**Item no.**	**Factor Loadings**	**AVE**	**CR**	**CA (α)**	**McDonald's Omega (ω)**
Desirable outcome			0.481	0.878	0.802	0.803
	DO2	0.601				
	DO3	0.600				
	DO4	0.862				
	DO5	0.705				
	DO6	0.594				
Willingness			0.512	0.886	0.801	0.816
	W2	0.588				
	W3	0.645				

	W4	0.880				
	W5	0.696				
	W6	0.562				
Implementation			0.533	0.842	0.762	0.774
	IM2	0.545				
	IM4	0.870				
	IM5	0.739				
	IM6	0.576				
Perceptions about inclusive teaching			0.516	0.848	0.805	0.811
	IT2	0.604				
	IT3	0.639				
	IT4	0.880				
	IT5	0.727				

AVE – average variance extracted; CR – composite reliability; CA – Cronbach's alpha reliability

The final version of the instrument was subjected to construct validity and reliability using the factor loadings in Table 2. Construct validity, which comprised convergent validity and discriminant validity, was achieved through CFA. As seen in Table 2, the AVEs for the constructs willingness (W), implementation (IM), and perception about inclusive teaching (IT) were 0.512, 0.533, and 0.516, respectively. These constructs explain over 50% of the variance in their observed indicators, suggesting that the items effectively capture the underlying constructs. However, for the construct, DO, the AVE was slightly lower (0.481) than the recommended threshold of 0.50 (Sujati et al., 2020). Despite this, the construct reliability remains acceptable, as reflected in the composite reliability score of 0.802 in Table 2, exceeding the recommended threshold of 0.70.

Moreover, the composite reliability scores of the constructs W, IM, and IT were 0.801, 0.762, and 0.777 respectively, indicating that the items are consistently reliable in measuring the various constructs. These were also supported by respective Cronbach's alpha (α) values of 0.802 for DO, 0.801 for W, 0.762 for IM, and 0.805 for IT, with all values exceeding the recommended threshold of 0.7. Furthermore, McDonald's Omega (ω) reliability was estimated for each construct, and the results revealed ω-values of 0.803, 0.816, 0.774, and 0.811 for DO, W, IM, and IT, respectively, with all values exceeding the threshold of 0.7 (Hayes & Coutts, 2020). Additionally, discriminant validity was determined using the Heterotrait-Monotrait ratio (Ab Hamid et al., 2017), as shown in Table 3.

***Table 3*:** *Discriminant validity of measured constructs using Heterotrait – Monotrait Ratio*

	DO	W	IM	IT
DO				-
W	-0.035			-
IM	-0.088	-0.004		-
IT	-0.076	-0.017	0.163	-

DO – desirable outcomes; W- willingness; IM – implementation; IT – perceptions about inclusive teaching

As indicated in Table 3, all HTMT values are below the threshold of 0.85, as stated by Ab Hamid et al. (2017), suggesting good discriminant validity.

3.4 Data collection and analysis

The final version of the instrument was used to gather data on-site from the main study participants (n = 253) to address the research questions. Specifically, research questions 1, 2, and 3 were answered at a significance level (α) of 0.05, using path analysis from structural equation modelling. However,

research question 4 was addressed by employing thematic analysis on the responses from the semi-structured interview.

3.5 Ethical considerations

To ensure ethically sound research, the study was ethically approved, and the participants were not obliged to partake in the study. As a result, written informed consent forms were obtained from participants. Additionally, confidentiality and anonymity were ensured in this study. Given this, participants' real names were not used in this study, but pseudonyms were.

4. Presentation of Results

The hypotheses were tested using path analysis through AMOS version 23. Goodness of fit (GOF) indices were estimated to determine how well the structural model fits the data. The results of the estimated GOF indices are presented in Table 4.

Table 4: *Goodness of fit measures for structural model*

GOF Measure	Result	Recommended threshold	Interpretation
χ^2 [*df*] (sig)	232.043 [129] (p=0.001)	p > 0.05	
χ^2 / *df*	1.799	≤ 3	
GFI	0.884	≥ 0.95	Excellent
AGFI	0.846	≥ 0.95	Excellent
CFI	0.912	≥ 0.95	Excellent
TLI	0.896	≥ 0.95	Excellent
SRMR	0.071	< 0.08	Excellent
RMSEA	0.063	< 0.06	Acceptable
P-Close	0.047	> 0.05	Excellent

The model fit results as shown in Table 4 revealed a mix of acceptable and excellent fit indices (χ^2 = 232.043; GFI = 0.884, AGFI = 0.846, CFI = 0.912, TLI = 0.896, RMSEA = 0.058, SRMR = 0.071, P-Close = 0.047) as suggested by Hu and Bentler (1999). This indicates that the model fits the collected data for the path analysis. The results of the path analysis are presented in Table 5.

Table 5: *Results of path analysis*

Path	Standardised coefficient (β)	SE	t-value	p-value	R^2
Implementation → inclusive teaching	0.156	0.073	2.137	0.040***	0.0243
Desirable outcome→inclusive teaching	-0.063	0.074	-0.851	0.450	0.0040
Willingness → inclusive teaching	-0.019	0.071	0.268	0.814	0.00036

As seen in Table 5, there was a significant positive relationship between implementation and inclusive teaching (β = 0.156, t = 2.137, p = 0.040). This indicates that pre-service science teachers' readiness to practice inclusivity (implementation) has a weak but positive influence on how they view and understand inclusive teaching. That is, for every unit increase in pre-service science teachers' readiness to practice inclusivity, there is a corresponding increase of 0.156 standard deviations in their overall perceptions of inclusive education. With regard to the amount of shared variance, pre-service science teachers' readiness to practice inclusivity explains 2.43% (R^2 = 0.0243) of the variance in their general perceptions of inclusive teaching.

Also, there was a non-significant negative relationship between desirable outcomes of inclusive education and pre-service science teachers' perceptions of inclusive education (β = -0.063, t = -0.851,

p = 0.450), as well as between pre-service science teachers' willingness to adopt inclusivity and their perceptions of inclusive education (β = -0.019, t = 0.268, p = 0.814). This means that for every one standard deviation decrease in desirable outcomes of inclusive education, the general perceptions of pre-service science teachers towards inclusive education decrease by 0.063 standard deviations. Also, for everyone standard deviation decrease in pre-service science teachers' willingness to adopt inclusivity, their general perceptions of inclusive education decrease by 0.019 standard deviations.

These results suggest that neither desirable outcomes of inclusive education nor pre-service science teachers' willingness to adopt inclusivity had a meaningful impact on their perceptions of inclusive education. Furthermore, outcomes of inclusive education accounted for only 0.40% ($R^2 = 0.0040$) and pre-service teachers' willingness to adopt inclusivity in their classrooms explained just 0.036% ($R^2 = 0.00036$) of the variance in their general perceptions of inclusive education, suggesting negligible contributions to the overall model.

This means that there is not enough evidence to suggest that the desirable outcomes of inclusive education or pre-service science teachers' willingness to adopt inclusivity significantly influence pre-service science teachers' perceptions of inclusive education in this model. The results also indicate that the model (desirable outcomes, willingness, and implementation) explained only 3.00% of the variance in pre-service science teachers' perceptions of inclusive teaching, with implementation being the only significant predictor and explaining the majority of the small variance. Figure 3 shows the structural model with the respective paths from the SEM.

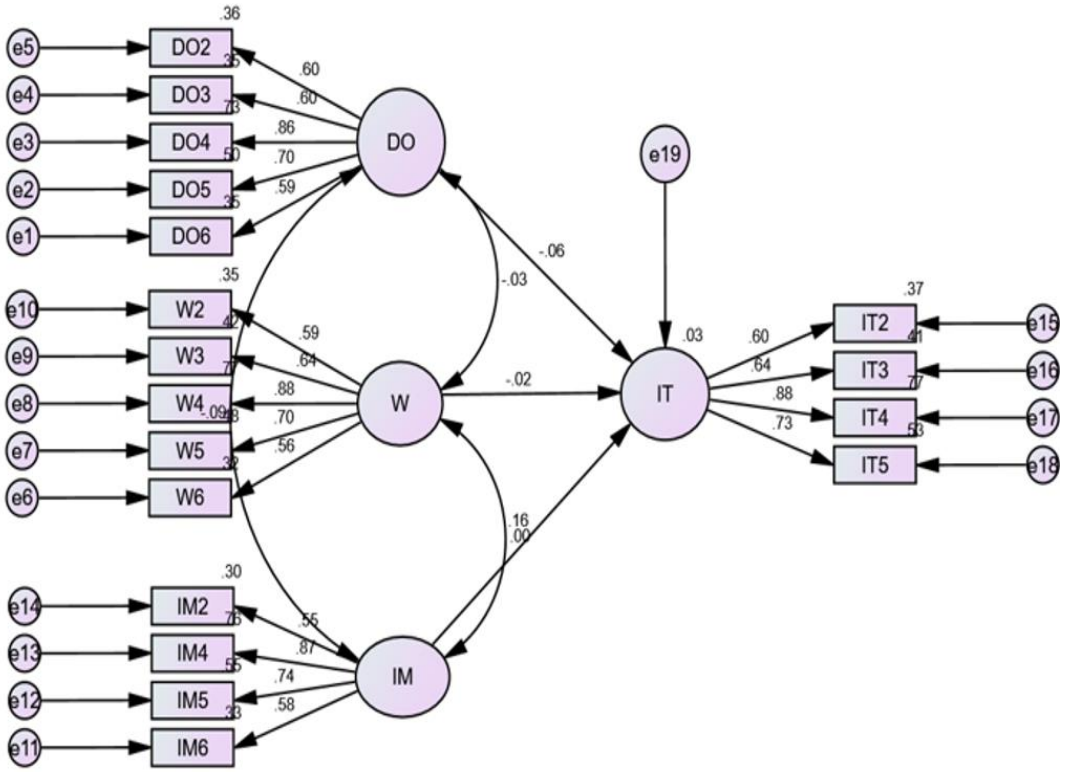

Figure 3: *Structural Path*

Given that implementation is the only significant predictor and explains the majority of the small variance, it suggests that other influencing factors were either omitted or inadequately measured. As a result, a qualitative interview was conducted to explain the quantitative results. The results from the interview revealed five major themes: The need for more practical experience, access to resources,

self-efficacy, classroom diversity, and adequacy of training. The various themes are analysed with sample responses from participants whose names are pseudonyms.

4.1 Theme 1: Practical application and hands-on experience

Pre-service teachers felt confident in their theoretical knowledge of inclusive education but expressed a lack of preparedness regarding practical application. The absence of hands-on experience can diminish their readiness to practise inclusive teaching, leading to uncertainty about their ability to implement inclusivity effectively. For instance, according to Sakyi, a male pre-service teacher:

> "*I understand the principles of inclusive education, but when I think about applying them in a real science classroom, I am not sure how to do it. Especially in science, where you have to manage lab work, I do not know how to make experiments accessible to all students*."

Similarly, Antwiwaa, a female pre-service science teacher added:

> "*I feel ready in theory, but I worry about not having practised enough. The only way I will feel fully prepared is if I can try these strategies out before starting my career*."

Moreover, Ernest, a male pre-service science teacher stated:

> "*We have been taught about inclusive teaching in lectures. But I have never had the opportunity to see it in action. I think it would be really helpful if we had more field experiences to practice adapting lessons for diverse learners*."

Additionally, according to Kisiwaa, a female pre-service teacher:

> "*I think that in science education, practicals are key, and I do not know if I have had enough exposure to how inclusive practices work during lab activities. It is one thing to talk about inclusivity, but another thing to apply it during lessons*."

4.2 Theme 2: Availability of resources and support

Pre-service science teachers expressed concerns about the lack of resources necessary for the effective implementation of inclusive education. They often noted that real-world classrooms may lack the technological and human resources needed to make inclusivity feasible. This includes assistive technologies, adaptive equipment, and additional staff support. The absence of these resources could hinder their ability to fully engage in inclusive practices, thereby affecting their perceptions of how successful they can be in fostering an inclusive environment. This factor was not included in the original model and could be crucial for explaining the low R^2. For instance, Owusuwaa, a female pre-service teacher, said

> "*In my ideal classroom, I would have all the resources I need, like adaptive equipment for students with physical disabilities. But I am not sure if most Ghanaian schools in real life have the budget or facilities to provide all of that*."

Again, Daniel, a male pre-service science teacher voiced out:

> "*I am concerned that in many schools, the resources will not be available. For example, in a science lab, how do I make sure students with mobility issues can fully participate in experiments without the right equipment*?"

Furthermore, Mansah, a female pre-service science teacher said:

> "*The concept of inclusivity sounds great, but without proper resources, it is going to be difficult to put into practice. I do not know if the school where I will be teaching will have the tools, we need to make it work*."

Likewise, Antony, a male pre-service teacher stated:

"*I think inclusivity is important, but I worry about whether I will have access to the resources I need. I do not know if there will be assistive technology available for students who need it. I do not know if I will have the needed staff support to help me manage students with special needs*."

4.3 Theme 3: Self-efficacy

Self-efficacy, the belief in one's ability to perform a given task, is a critical factor in a teacher's readiness to implement inclusive education. While pre-service science teachers expressed some confidence in their knowledge of inclusive practices, they also experienced a significant level of anxiety about their ability to effectively manage an inclusive classroom. This lack of confidence can undermine their readiness to teach inclusively, as reflected in their responses. For example, Nkrumah, a male pre-service teacher, highlighted that:

"*I feel like I have the basics now, but I am still not 100% confident. I am nervous about how things will go when I am actually in the classroom, especially if I have students with very different needs*."

To add to Nkrumah's voice, Frimpomaa, a female pre-service science teacher remarked that:

"*There is a part of me that feels ready, but I also feel like I might not have all the tools or confidence to handle every situation. I think it is a lot to manage, especially if you have never done it before*."

In the same way, Alhassan, a male pre-service science teacher stated:

"*I believe I know how to make a classroom inclusive in theory, but I am nervous about how to handle it all in practice. I will probably have to learn a lot on the job*."

Also, Comfort, a female pre-service science teacher noted that:

"*I think I can do it, but I am also worried about failing. What if I cannot manage to adapt my lessons well enough for all students to understand the content*."

4.4 Theme 4: Classroom diversity and time constraints

Managing a classroom with students of varying abilities, backgrounds, and learning needs presents a challenge for pre-service teachers. Many express concerns about having enough time and resources to address these diverse needs effectively. For instance, Amina, a female pre-service science teacher stated:

"*In a diverse classroom, I am not sure how I will be able to manage students with very different learning needs all at once. Will I have time enough to make sure everyone is keeping up*?"

In another voice, Philip, a male pre-service science teacher also said:

"*The idea of managing diverse classrooms feels overwhelming. I do not know how I will be able to meet the needs of students with different learning abilities in the time I may have*."

Again, Jessica, a female pre-service science teacher stated:

"*I think one of the biggest challenges will be making sure I can adapt lessons for everyone. Some students may need more time or help, and I am worried about how to balance that with keeping the rest of the class on track*."

Emmanuel, a male pre-service science teacher also remarked that:

"*I have heard a lot about how diverse classrooms are becoming, but that also means I will need more time and support to manage everything. I am not sure how realistic it is to expect one teacher to meet every student's needs*."

4.5 Theme 5: Need for further training

Pre-service teachers felt that their training in inclusive education, particularly regarding the practical aspects of teaching science, was insufficient. While they understand the principles of inclusive education, they feel underprepared to put these principles into action. This gap in training could

explain their hesitance about being ready to implement inclusivity, and it may also account for the low variance explained in the model. According to Owusu, a male pre-service science teacher:

> "*We have had some good discussions about inclusive teaching, but I do not think it is enough. I think we need more specific training, especially in adapting science lessons to different students' needs*."

Asantewaa, a female pre-service science teacher, speaking about the need for further training also stated:

> "*I feel like we have only scratched the surface. I think more training on how to make science class inclusive would be really helpful, especially hands-on workshops*."

Francis, a male pre-service science teacher also made his voice known on this subject. According to Francis,

> "*I think I will need more training before I feel ready to implement inclusivity in a science classroom. There is a lot we have not covered, and I do not feel fully prepared yet*."

Agnes, a female pre-service science teacher also expressed that:

> "*Our course on inclusive education has been more focused on the theory of inclusivity, but I wish we had more practical advice on how to apply it, particularly when it comes to science experiments*."

From the pre-service teachers' responses in the interview, it is evident that several influential factors are missing, which could explain the low variance (R^2) accounted for by the SEM model. While the model focuses on implementation, willingness, and desirable outcomes, other significant influences—such as practical experience, access to resources, self-efficacy, classroom diversity, and adequacy of training—could play a critical role in shaping pre-service science teachers' perceptions of inclusive teaching. Incorporating these factors into the model in future studies could provide a more comprehensive understanding of the variables affecting pre-service teachers' perceptions of inclusive teaching.

5. Discussion of Findings

The main aim of this study was to explore the synergy among factors influencing Ghanaian pre-service science teachers' perceptions of inclusive science teaching. The factors considered were desirable outcomes of inclusive education, willingness to adopt inclusivity, and the implementation of inclusive education. The results revealed that among the predictors, implementation of inclusive education emerged as the only significant factor, suggesting that pre-service science teachers' readiness to practise inclusivity positively influences their perceptions. Implementation, as measured in this study, reflects pre-service teachers' confidence and preparedness to design and deliver inclusive science lessons. Thus, pre-service science teachers with a positive disposition toward inclusive education (demonstrated through their readiness to design and incorporate inclusive strategies) were more likely to develop favourable perceptions of inclusive education. This aligns with the Theory of Planned Behaviour's (TPB) construct of attitudes, which directly shape intentions and behaviours, as demonstrated in the theoretical basis of this study.

Contrarily, desirable outcomes of inclusive education and pre-service science teachers' willingness to adopt inclusivity were not significant predictors of the perceptions they hold about inclusive education. This finding suggests that willingness, as conceptualised in this study, was not strongly driven by subjective norms. TPB posits that subjective norms (social expectations and pressures) can significantly shape behavioural intentions. Additionally, the lack of a significant relationship between desirable outcomes of inclusive education and pre-service science teachers' perceptions of inclusive education is particularly intriguing. In TPB, behavioural beliefs about desirable outcomes often shape attitudes and subsequent behaviours (Opoku et al., 2021). The expectation would be that pre-service science teachers who perceive inclusive education as leading to desirable educational outcomes would hold stronger positive perceptions of inclusivity. However, the non-significant

result suggests that pre-service science teachers did not strongly associate inclusive education with clear or tangible outcomes, such as improved student engagement or learning performance.

The non-significance of the desirable outcomes of inclusive education and pre-service science teachers' willingness to adopt inclusive education further emphasises the primacy of practical readiness over theoretical understanding or intrinsic motivation. For example, qualitative data gathered in this study revealed that participants expressed uncertainty about how inclusivity benefits classroom dynamics, particularly in resource-limited environments. Some pre-service science teachers questioned whether inclusivity could be effectively implemented in settings with large class sizes and diverse student needs. This finding reflects a broader issue in teacher preparation programmes, where a disconnect between knowledge and practice often hinders the successful adoption of new teaching approaches. This observation aligns with the literature, as Cate et al. (2018) and Savolainen et al. (2022) argue that knowledge or motivation alone is insufficient to drive change; practical experience and self-efficacy are critical. If pre-service teachers do not feel that their training programmes emphasise inclusivity or that they will be supported in its implementation, their willingness may not be pronounced or influential in shaping their perceptions of inclusive education. This underscores the need for teacher preparation programmes to go beyond theoretical instruction, focusing instead on equipping pre-service teachers with the tools, skills, and experiences necessary to implement inclusive strategies effectively.

Additionally, qualitative data in the form of interviews were conducted, offering critical insights into the factors that may explain and expand on the quantitative findings. Five themes emerged: practical application and hands-on experience, availability of resources and support, self-efficacy, classroom diversity and time constraints, and the need for further training. The study respondents highlighted how the theoretical emphasis in their training did not translate into real-world applicability, leaving them underprepared. This lack of practical exposure directly affects perceptions, as it creates a gap between knowledge and implementation. The significance of implementation as a predictor in the SEM model can thus be linked to this practical deficit. Studies by Tumkaya and Miller (2020), Crispel and Kasperski (2021), Massouti (2021), and Wray et al. (2022) have similarly shown that experiential learning opportunities, such as internships in inclusive settings, enhance teachers' readiness and perceptions.

The absence of adequate resources emerged as a critical theme in the qualitative analysis. Participants expressed frustration about the lack of assistive technologies, adapted materials, and infrastructure to support inclusive education. Pappas et al. (2018), Schuelka (2018), Opoku-Nkoom and Ackah-Jnr (2023), and Carey (2024) noted that inadequate resources and infrastructure are among the most significant barriers to inclusive education, particularly in developing countries. The low variance explained in the structural equation model (SEM) could partly be attributed to this resource gap. While pre-service science teachers may feel theoretically prepared to adopt inclusive education strategies, their perceptions are negatively influenced when they foresee practical challenges due to insufficient support.

Participants also expressed nervousness about managing diverse classrooms, fearing they might fail to meet the needs of students with varying abilities. This anxiety reflects low self-efficacy, which Bandura (1997) identified as a critical determinant of teachers' attitudes toward challenging pedagogical practices. This low self-efficacy may explain why willingness was not a significant predictor in the SEM model. Participants emphasised the importance of learning strategies for adapting science lessons to accommodate diverse learners. This finding corroborates studies by Goddard and Evans (2018), Ramakrishnan (2020), Kefallinou et al. (2020), and Alsarawi and Sukonthaman (2023), which argue that targeted training is the cornerstone of successful inclusive education. The significant role of implementation in the SEM highlights the impact of training on

perceptions. When teachers are equipped with practical strategies and real-world skills, they are more likely to view inclusive education positively and feel confident in their ability to enact it.

Additionally, participants reported concerns about balancing the needs of students with disabilities, gifted learners, and those requiring differentiated instruction. This aligns with the findings of Mprah et al. (2023), who noted that the perceived time-intensiveness of inclusive teaching often discourages teachers from adopting it.

6. Conclusions and Recommendations

This study sheds light on the factors influencing Ghanaian pre-service science teachers' perceptions of inclusive education, emphasising the critical role of desirable outcomes of inclusive education, willingness to adopt inclusivity and the implementation of inclusive education. From the findings, it can be concluded that the implementation (practical readiness) of inclusive education significantly predicts Ghanaian pre-service science teachers' perceptions of inclusive education. However, willingness to adopt inclusivity and desirable outcomes of inclusive education were not significant contributors. Additionally, it can be concluded that while Ghanaian pre-service science teachers may recognise the importance of inclusive education, structural and emotional barriers significantly hinder their perceptions and readiness to implement inclusive education.

Based on the findings of this study, it is recommended that teacher training institutions in Ghana should prioritise experiential learning opportunities, such as inclusive teaching practicums, classroom simulations, or mentorship programmes, to bridge the gap between theoretical instruction and practical application. This will help build pre-service science teachers' confidence and readiness to implement inclusive practices. Furthermore, pre-service teachers should have access to peer learning groups and exposure to best practices that can alleviate the anxiety associated with managing diverse classrooms, thereby fostering positive perceptions of inclusive education. Additionally, broader structural changes, such as reducing class sizes, offering flexible curricula, and creating inclusive policies, should be implemented to alleviate the challenges faced in the implementation of inclusive education.

6.1 Limitations and suggestions for further research

In spite of the findings obtained, the study is characterised by some limitations. Firstly, the quantitative analysis revealed a low variance explained ($R^2 = 0.0030$) for pre-service science teachers' perceptions of inclusive education, indicating that key influencing factors were not captured in the measurement model. This limitation restricts the generalisability and explanatory power of the findings and highlights the need for incorporating additional variables in future research. Secondly, the findings of this study are situated within a specific geographical context, potentially limiting their applicability to other regions or countries with different structural and cultural dynamics in education. Lastly, the study's sample was drawn from a single-teacher education institution. As a result, the findings may not be representative of pre-service science teachers in diverse educational settings.

Due to the limitations highlighted, some suggestions are made for researchers to consider in future studies. First of all, further studies should explore the potential predictors of the factors considered in this study to better understand the low variance explained. Additionally, the themes from the qualitative results indicate that they play a significant role in shaping the perceptions of pre-service science teachers. Therefore, future studies could consider incorporating these factors into the measurement model to increase its explanatory power. This would also offer a more comprehensive understanding of the variables affecting pre-service science teachers' perceptions of inclusive education. Furthermore, in determining the instrument's convergent validity, the AVE for the construct "desirable outcomes of inclusive education" was slightly lower (0.481) than the recommended threshold of 0.50. However, composite reliability was achieved (0.802). Therefore, the

authors suggest that the measurement items for desirable outcomes of inclusive education be refined in future studies to improve convergent validity.

7. Declarations

Authors contributions: Conceptualisation (E.A.T, E.T.A & B.O.O.); Literature review (P.O.A.); methodology (E.A.T. & E.T.A.); software (N/A); validation (B.O.O. & P.O.A.); formal analysis (E.A.T & E.T.A.); investigation (E.A.T. & E.T.A.); data curation (N/A) drafting and preparation (E.A.T. & E.T.A.); review and editing (B.O.O. & P.O.A.); supervision (B.O.O.); project administration (E.A.T.); funding acquisition (N/A). All authors have read and approved the published version of the article.
Funding: The study received no external funding.
Acknowledgements: The authors declare no acknowledgements.
Conflicts of Interest: The authors declare no conflict of interest.
Data availability: Following ethical standards and the stipulations outlined in the consent agreement with participants, the data must be kept confidential. Nevertheless, individuals seeking further information may contact the corresponding author.

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