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Table of Contents

TEACHERS' SELF-EFFICACY, IDENTITY AND SECONDARY SCHOOL STUDENTS' ACHIEVEMENT IN QUANTITATIVE ANALYSIS IN CHEMISTRY IN DIFFERENT LOCAL GOVERNMENT AREAS IN OYO STATE, NIGERIA

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Abstract
This study investigated the correlation between teacher self-efficacy, identity, and chemistry students' achievement in quantitative analysis. The study employed a correlational survey research design. The sample consisted of 40 chemistry teachers and 400 students from 40 randomly selected public schools in four local government areas in the Ibadan metropolis. Data were collected using well-validated instruments and analyzed using descriptive statistics (frequency, average, and standard deviation) and inferential statistics (Pearson Product Moment Correlation and Multiple regression). The results showed that the level of performance of students in quantitative analysis was low (38.55). In addition, teachers' self-efficacy was linked to the performance of students in quantitative analysis ($r = 0.87$; $p \leq 0.05$). There was a positive and moderately significant relationship between teacher identity and student performance ($r = 0.54$; $p \leq 0.05$). In conclusion, chemistry students' performance in quantitative analysis was somewhat influenced by the teachers' self-efficacy and identity. Therefore, efforts should be made to improve the teachers' professional development programme aimed at fostering their capacity to teach quantitative analysis effectively.

Keywords: Teachers' self–efficacy, Teachers' identity, Students' achievement in chemistry

Introduction

Quantitative analysis (QA) is a part of analytical chemistry that mainly comprises volumetric and gravimetric analyses. It is a vital aspect of Nigeria's secondary school chemistry curriculum, in which students learn to master measurements, stoichiometric calculations, and data interpretation. This branch of chemistry deals with the determination of the amount or percentage of one or more substances within a sample. QA basically provides numerical figures about the composition of a substance and allows for precise quantities and calculations. While experimenting with chemical reactions, QA helps the students to predict how much product to expect and also to determine the actual outcome (Helmestine, 2019). Quantitative analysis is vital to food and drug production and testing. It is also used to measure the nutrient levels and ensure the accuracy of dosage. Students can use quantitative analysis to understand a wide range of analytes, especially while performing organic and inorganic analysis (Vedatu, 2021). This aspect of chemistry demands analytical thinking, precision, and problem-solving skills, which some students may find challenging (Okebukola, 2020).

It is no longer news that the academic achievements of chemistry students in Nigerian schools, both in external and internal examinations, are not encouraging (Samuel & Ukpoh, 2021). There appears to be a considerable failure of chemistry in the West African Examinations Council (WAEC) and the National Examinations Council (NECO). Particularly, the Chief Examiner's report of the West African Examinations Council (WAEC) (2019, 2020) reported students' weaknesses in the concepts related to quantitative analysis, such as gramme concentration, percentage purity, and molar concentration. Generally, students' underperformance in this core concept has persisted. This was corroborated by Idika and Aromilehin (2024), who found that 72.5% of chemistry students scored low in quantitative analysis. Quantitative Analysis has also been named as one of the topics that students perceive as difficult (Kyado, Achor, & Adah, 2021; Oladejo, Okebukola, Olateju, Akinola, Ebisin, & Dansu, 2022; Oladejo, Ademola, Ayanwale, & Tobih, 2023). There is a notion that teacher-related factors, among others, could determine students' achievement in quantitative analysis concepts (Igwe, 2015; Bolaji, Oyeniyi, Kolawole 'Abdulsalam, Shittu, & Anwo, 2024).

The Nigerian educational system has increasingly prioritized improving teacher quality to boost student outcomes in science subjects (Federal Ministry of Education, 2020). The persistent underachievement in quantitative analysis may, in part, underscore the need to examine pedagogical and psychological factors that influence their outcomes. Most research in this area has focused on the former. However, it may be expedient to consider the latent characteristics of the teacher.

In research, a list of teacher-related variables has emerged as probable contributors to students' academic success, which may offer insights into improving chemistry education in this context. Teachers' self-efficacy is one of these. This construct represents a form of competence belief and is defined as teachers' belief in their ability to organize and accomplish teaching tasks effectively. However, Waddington (2023) opines that this belief is only perceived and not necessarily the authentic valuation of the teacher's capability. Rooted in Bandura's (1977) social cognitive theory, self-efficacy describes a teacher's enthusiasm, resilience, and persistence in teaching. High teacher self-efficacy is often associated with the use of innovative instructional strategies, creativity in problem-solving, and enhanced student engagement, particularly in complex subjects like quantitative analysis (Zee & Koomen, 2016; Hussain, Khan, & Bidar, 2022). The contrast is in the case of teachers with low self-efficacy.

Teachers' self–efficacy has progressively gained an important role in research as a result of its implications for instructional practices and students' achievement (Barni, Danioni, and Benevene, 2019; Ma, 2022; Okoro, Nwagbo, Ugwuanyi and Ugwu, 2022). In addition, self-efficacy is crucial for achieving better teacher effectiveness and learner outcomes (Karim, Masud, Nesa Subarna, Billah, & Wienaah, 2021). Adu-Gyamfi and Asaki (2023) affirmed that one of the factors that determined teachers' ability to teach chemistry is professional competence. Teachers with high self-efficacy may creatively adapt limited resources to teach, increasing learner motivation and goal orientation.

Teacher identity, on the other hand, encompasses the values, beliefs, and commitments educators bring to their profession, which shape their teaching practices and classroom dynamics. A considerable level of professional identity sustains their commitment despite systemic constraints (Sodipe, 2022). A strong professional identity

fosters motivation, resilience, and a commitment to student success (Ogunniyi & Rollnick, 2015). In chemistry education, where quantitative analysis requires both content mastery and pedagogical skill, it is presumed that teachers with a well-defined identity are better equipped to create supportive learning environments that may help to enhance students' understanding of concepts. Similarly, a well-defined teacher identity promotes reflective teaching, adaptability, and positive teacher-student relationships, all of which are critical for student success (Canrinus et al., 2017).

The interplay between self-efficacy and identity is particularly relevant in science education, where subject-specific demands confidence and a clear sense of purpose. Teachers who exhibit both attributes tend to adopt student-centred approaches, use practical demonstrations, and scaffold complex concepts, thereby improving student performance in quantitative analysis (Woo et al., 2018). Perhaps, investigating the relationship between teachers' self-efficacy, identity, and students' performance in quantitative analysis can inform targeted interventions, such as professional development programmes tailored to chemistry education (Igwe, 2015).

Literature review

In a study conducted by Okoro, Nwagbo, Ugwuanyi, and Ugwu (2022), it was discovered that secondary school students in Enugu State who were taught by high and moderately efficacious teachers had higher achievement in Biology than those taught by lower self–efficacious teachers. In a related study, Oviawe and Omo (2021) investigated the self-efficacy and qualification of technical teachers, as correlated with the achievement of students. They found an important relationship between the teachers' self-efficacy and the achievement of the students. Tajudeen (2021) found that the correlation between self-efficacy and student academic achievement was weak, varied, and, in some cases, of no significant relationship due to problems of poor participation, poor teaching methods, and poor classroom management.

Empirical research highlights a positive correlation between teachers' self-efficacy and student achievement in science subjects. For instance, Zee and Koomen (2016) found that self-efficacious teachers foster greater student engagement and academic performance. There

is a notion that teachers' self-efficacy could influence students' achievement (Hussain, Khan, & Bidar, 2022; Waddington, 2023). However, Jerrim, Sims and Oliver (2023) held contrary views to this, suggesting that there may be other confounding factors that seem to interfere with this popular assumption. Shahs and Bhattarai (2023) suggested that learning outcomes could be fostered when a teacher adequately combines their teaching skills, knowledge of content, and self-efficacy.

In chemistry, where quantitative analysis demands conceptual understanding and procedural skills, teachers' self-efficacy, grounded in Bandura's (1977) framework, directly impacts students' mastery of the subject. In Nigeria, where chemistry is a prerequisite for science-related careers, enhancing teacher self-efficacy could significantly contribute to national development (Okebukola, 2020).

In addressing students' underachievement in STEM concepts, particularly chemistry and quantitative analysis (QA), much research has focused on areas related to curriculum content, infrastructure, and pedagogical practices rather than on teachers' psychological and professional attributes. It is supposed that strengthening teachers' self-efficacy and professional identity could transform instructional practices, enhance student performance, and contribute to broader educational goals in sub-Saharan Africa.

Therefore, this study explored the relationship between self-efficacy, identity, and students' achievement in QA. It is hoped that the findings will provide empirical evidence for stakeholders to develop evidence-based interventions that improve instructional quality and raise chemistry education standards in the Ibadan Metropolis.

Research Questions

Four research questions guided this study;

1. What is the mean achievement score of students in quantitative analysis?
2. What is the relationship between teachers' self-efficacy and students' achievement in quantitative analysis?
3. What is the relationship between teachers' identity and students' achievement in quantitative analysis?

4. What is the combined relationship between teachers' self–efficacy and identity and students' achievement in quantitative analysis?

Methodology

The study adopted the correlational survey research design. The participants in this study comprised of forty (40) chemistry teachers and four hundred (400) SSIII students from forty (40) selected public secondary schools in four local government areas of the Ibadan metropolis, using a simple equal allocation method. However, gender distribution was not considered during sampling. The researcher adapted the Teachers' Self-Efficacy Scale (TSES) and the Teachers' Identity Scale (TIS) questionnaires. The reliability of the four Likert scale was determined using Cronbach's Alpha. The values obtained were 0.71 and 0.83, respectively. Using past external examination questions as a guide, a pool of questions in Quantitative analysis was generated. After thorough scrutiny, the achievement test was developed after expunging some items that were found to be too difficult or too easy. The 20-item multiple-choice test was validated using the KR-21 method.

Before the data collection period, necessary authorisations were obtained from the sampled schools, and the SSIII chemistry students who had already been taught the concept were notified of the test in advance. The willingness of the teachers to participate in the study was ascertained.

The Quantitative Analysis Achievement Test (QAAT) was administered on the students, while the TSES and the TIS questionnaires were administered on the selected teachers. All data were collated for analysis using descriptive statistics (mean, frequency, percentage), Pearson Product-Moment Correlation, and Multiple regression. The level of significance was determined at 0.05 level of significance.

Results

Research Question 1: What is the Achievement Score of Students in Quantitative Analysis?

Table 1: Categorical scores of students in quantitative analysis.

Level	Score range	Frequency	Percentage (%)
Low	0 - 49	211	52.8
Moderate	50 - 69	174	43.5
High	70 - 100	15	3.7
Total	100	400	100
Mean = 38.55			

The descriptives in Table 1 are an analysis of student performance in quantitative analysis. Of the 400 students sampled, 211 (52.8%) scored in the low achievement category (0–49), 174 (43.5%) in the moderate category (50–69), and only 15 (3.7%) achieved high scores (70–100). The mean score of 38.55, falling within the low achievement range, underscores the pervasive underperformance in this critical area of chemistry education.

Research Question 2: What is the Relationship Between Teachers' Self-Efficacy and Students' Achievement in Quantitative Analysis?

Table 2: Relationship Between Teachers' Self–efficacy and Students' Achievement in Quantitative Analysis

Variables	Mean	SD	df	r	P - value	Remark
Students' achievement	7.71	3.60	41	0.813*	0.000	Significant
Teachers' self–efficacy	45.54	15.24				

* denotes significance at 0.05 level of significance.

Table 2 reveals a strong, positive, and statistically significant relationship between teachers' self-efficacy and students' achievement in quantitative analysis ($r = 0.813$, $p < 0.05$). This finding indicates that teachers who possess greater confidence in their instructional abilities are associated with significantly higher student performance in this challenging domain.

Research Question 3: What is the Relationship Between Teachers' Identity and Students' Achievement in Quantitative Analysis?

Table 3: Relationship Between Teachers' Identity and Students' Achievement in Quantitative Analysis

Variables	Mean	SD	df	r	p-value	Remark
Students' achievement	7.71	3.60	41	0.539	0.000	Significant
Teachers' identity	43.00	17.11				

*denotes significance at 0.05 level of significance.

Table 3 indicated a moderate, positive, and statistically significant relationship between teachers' professional identity and students' achievement in quantitative analysis ($r = 0.539$, $p < 0.05$). This suggested that teachers who have a well-developed sense of their professional role, values, and commitment to education positively influence student outcomes, though the effect is less pronounced than that of self-efficacy.

Research Question 4: What is the Combined Relationship of Teachers' Self-Efficacy, Identity with Students' Achievement in Quantitative Analysis?

Table 4: Combined Relationship of Teachers' Self-Efficacy, Identity with Students' Achievement in Quantitative Analysis

Source of variance	Sum of square	df	Mean square	F	Significant
Regression	73.348	2	36.674	68.267	0.000*
Residual	20.408	38	0.537		
Total	93.756	40			
R = 0.884 R Square= 0.782 Adjusted R square= 0.771 Std Error of the Estimate= 0.73284					

*denotes significance at 0.05.

Table 4 presented a multiple regression analysis, revealing a strong, positive, and statistically significant combined relationship between teachers' self-efficacy, professional identity, and students' achievement in quantitative analysis ($R = 0.884$, $p < 0.05$). The R-squared value ($R^2 = 0.782$) indicated that 78.2% of the variance in student achievement can be explained by these two independent variables, with an adjusted R^2 of 0.771. The low standard error (0.73284) and high F-value (68.267, $p < 0.001$) further validated the predictive power of the model.

Discussion

This study investigated the correlational effects of teachers' self-efficacy and professional identity on students' achievement in quantitative analysis within the chemistry curriculum across secondary schools in Ibadan Metropolis, Nigeria. The alarmingly low achievement scores (52.8% in the low category) highlighted the need for urgent interventions.

This low achievement aligned with previous studies in Nigeria, which have consistently reported poor student outcomes in chemistry,

particularly in topics like quantitative analysis (Ibrahim, 2019; Igwe, 2015). Several factors may have contributed to this trend. Quantitative analysis, which involves stoichiometry, molar calculations, and data interpretation, demands a robust foundation in mathematical skills, problem-solving abilities, and the capacity to connect theoretical concepts to practical applications. Many students may lack these prerequisites due to gaps in prior education or inadequate instructional support.

Contextual factors in Nigerian secondary schools, such as limited access to laboratory facilities, insufficient instructional materials, and large class sizes, may exacerbate these challenges (Igwe, 2015). Moreover, teacher-related variables, such as pedagogical competence and confidence, played a pivotal role in shaping student outcomes, as evidenced by the subsequent research questions. The low mean score suggested an urgent need for targeted interventions, including curriculum reforms that emphasize foundational skills, hands-on learning experiences, and diagnostic assessments to identify and address student weaknesses early in the learning process.

Furthermore, the positive relationship between teachers' self-efficacy and students' achievement is in line with Bandura's (1997) social cognitive theory, which posited that self-efficacy influences individuals' effort, persistence, and goal-setting behaviors. Teachers with high self-efficacy are more likely to employ innovative pedagogical strategies, such as interactive demonstrations, scaffolded problem-solving, and formative assessments, which are particularly effective in teaching complex topics like quantitative analysis (Tschannen-Moran and Hoy, 2007).

The strength of the correlation ($r = 0.813$) highlighted the critical role of teacher self-efficacy in STEM education, where technical proficiency and clarity in instruction are paramount. For instance, efficacious teachers may excel at breaking down abstract concepts, such as molarity or titration calculations, into manageable steps, thereby enhancing student comprehension. The significant p-value ($p < 0.001$) reinforced the robustness of this relationship, suggesting that self-efficacy is a key predictor of student success.

In another vein, the study found that teachers' identity correlates with students' achievement in chemistry. Teachers with a strong identity are likely to exhibit dedication, enthusiasm, and

resilience, even in resource-constrained environments like Nigerian secondary schools. These qualities may translate into behaviors that enhance student engagement, such as setting high expectations, fostering a positive classroom culture, and modeling problem-solving strategies (Korthagen, 2017).

The moderate correlation ($r = 0.539$) suggested that teacher identity operates as a complementary, rather than primary, driver of student achievement. Unlike self-efficacy, which directly influences specific teaching tasks, identity is a broader construct that encompasses personal and professional dimensions. In the context of quantitative analysis, teachers with a strong identity may inspire students to persist through challenging content, but their impact may be limited by technical or pedagogical constraints. For example, a committed teacher may struggle to teach titration effectively without access to laboratory equipment.

The significant p-value ($p < 0.001$) confirmed the importance of teacher identity, particularly in challenging educational contexts. In Nigeria, where teachers face systemic barriers such as low salaries, administrative overload, and inadequate resources, a strong professional identity may help sustain their motivation and effectiveness (Igwe, 2015).

This finding highlighted the effect of teachers' self-efficacy and identity in driving student performance. While self-efficacy contributes directly through effective instructional practices, such as clear explanations and targeted feedback, identity reinforced these efforts by fostering a sense of purpose and commitment. Together, these factors create a conducive learning environment that supports students' mastery of quantitative analysis. The high multiple correlation coefficient ($R = 0.884$) suggested that interventions targeting both constructs could yield substantial improvements in student outcomes.

At the same time, the strong relationships observed ($R = 0.884$ for combined effects) underscored the potential of teacher-focused strategies to drive improvement. By enhancing teachers' self-efficacy and professional identity through targeted training and supportive policies, educational stakeholders can transform student outcomes in this challenging domain.

Conclusion

This study established that teachers' self-efficacy and professional identity are significant factors influencing students' achievement in quantitative analysis, highlighting their crucial role in shaping the quality of chemistry education in Nigeria.

Recommendations

Based on the findings of this study, the following recommendations were made:

1. To improve students' achievement in quantitative analysis, teachers should try to develop a high sense of efficacy through involvement in professional programmes, workshops, and seminars.
2. Education authorities should ensure the recruitment of dedicated and professionally qualified chemistry teachers in secondary schools.
3. Regular conferences, seminars, and workshops should be organized for chemistry teachers to update their pedagogical skills.

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