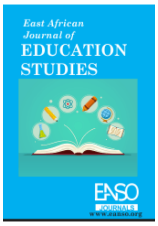

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Original Article

Professional Development and Science Teacher Effectiveness in Africa: A Study of South Western Uganda

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ABSTRACT

Teacher Professional Development (TPD) has long been a factor in revolutionizing the quality of science education in Africa. Although the Ugandan government introduced many TPD initiatives, there have been noticeable failure rates in science subjects at the Uganda Certificate of Education (UCE) examinations countrywide. This study aims to interrogate the level of science teacher engagement in professional development, challenges hindering teacher access to TPD programs, and the correlation between TPD and teacher effectiveness in terms of science grades. Using the Mixed method design, a sample size of 100 science teachers was recruited. The major findings revealed glaring gaps relating to inadequate teacher involvement in professional development, lack of planning for professional training of science teachers, limited funding and negative attitude towards professional development by science teachers and the school administration. The study provides a promising revelation that engagement in TPD positively correlates ($\pi = 0.473$, $p < 0.01$) with science teacher effectiveness. The study points to a critical argument that in order to deconstruct the narrative that STEM performance is supposed to be low and historically few students take on these disciplines, there is a need to invest in professional growth for science teachers.

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INTRODUCTION

The world is steadily embracing a science and technology revolution. Science and technology are driving industrialization and economic development globally. Even African states have established policy agendas that will steer them to steadily embrace science and technological advancements in all economic sectors. For instance, the Africa Vision 2063, the East African Agenda 2050, and Uganda Vision 2040 are testimony to the fact that Africa is steadily planning her way into becoming a huge science and technology hub (African Development Bank, 2023). Indeed, if we are to realize African emancipation and her eventual detachment from Western neo-colonialism, this is the time she must support the battle for science and technology in her growth trajectory. However, who is responsible for producing future African scientists that will lead the continent into a science region in the future? One simple answer to this question is—the school. The role of Africa's education policymakers is to design policies for science teaching in schools (Adeyemi & Okeke, 2023). Encouraging and succeeding to push for a science revolution in schools means investing in teacher effectiveness (Moyo et al., 2024).

Several scholars (Komba & Nkumbi, 2018; Kim & Lee, 2020) have agreed that teacher effectiveness is a critical factor in promoting quality education and positive learning outcomes worldwide. Effective teachers inspire and empower students, contribute to educational equity, and shape the skills of future generations (UNESCO, 2015; Hattie, 2009; Hanushek & Rivkin, 2010; OECD, 2019). Teacher effectiveness is defined as the ability of teachers to impact their students' grades and instill impactful knowledge (Musimenta et al., 2020; Sekiwu, 2013; Sekiwu, 2023; Alsubaie, 2024). However, for teacher effectiveness to occur, teachers must acquire and utilize pedagogical and technical knowledge to influence learning (Darling-Hammond, 2000; Marzano, 2003; Stronge, 2007). Pedagogical and technical knowledge should be constantly upgraded for teachers to keep in touch with new education changes and to remain continually effective in their profession (Hattie, 2012).

One strategy to keep teachers effective in their teaching is by encouraging them to invest in various teacher professional development (TPD) programs. Wanzare and Da Costa (2000) define TPD as those training initiatives that enrich teaching methods and increase the teacher's ability to tackle diverse student academic needs. TPD is therefore the consistent development of teacher skills to match them with the ever-evolving educational changes. Some TPD programs include the induction, mentorship and in-service capacity building of teachers. The aim of these TPD programs is to However, the type of professional training that teachers receive should enable them connect with the local society in order to enable them to provide relevant education. This defines a competency-based education system. Any educational system disconnected from society's indigenous direction loses sight of its competence-based character and is unable to foster social freedom. It is vital to rebuild the potential of indigenous African epistemologies, formerly disdained by colonialism. This will support Africans in achieving their development objectives. Instead of stealing other diasporic cultures, Africa's educational agenda must be conceived in accordance with its original ideology (Sekiwu, 2023).

Classroom management requires the passionate capability of teachers to involve students in activities that will promote effective learning. Such activities range from the application of effective instruction methods, seeking positive student feedback, and getting students to think critically and creatively, while applying what they have learned in practical social environments. In other words, effective classroom management is a window for the smooth implementation of competence-based learning in African education (Sekiwu, 2023).

In Uganda, the TPD model has been central to the Ministry of Education and Sports (MoES)'s concern to galvanize academic achievement in

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sciences at the post-primary level (Ministry of Education & Sports, 2015). This concern intensified between 1990 and 2000 with various interventions set with the aim of refining student grades in science disciplines (Njoki, King-White, Kinai & Kigen, 2019; Mugimu & Opolot-Okurut, 2017). Such TPD interventions include the Teacher Development and Management System (TDMS), a comprehensive in-service teacher training program launched in 2010. The Teacher Induction and In-Service Training Program (TITP) began in 2000 to support new and experienced teachers, and the Integrated In-Service Teacher Education Program (INSTEP), was introduced in 2000 in partnership with development agencies and Civil Society Organizations (Kiconco & Okurut, 2015; Asiimwe, 2018; Kyomya et al., 2019).

Following the recommendations of the 1987 Education Policy Review Commission (EPRC), the Ugandan government, in a bid to encourage Science, Technology, Engineering, and Mathematics (STEM) teaching, introduced the Science Education Policy in 2005. This policy made science subjects such as Physics, Chemistry, Biology, and Mathematics obligatory for all secondary school students up to form four (Musimenta et al., 2020). To further boost enrollment in science programs, the government of Uganda reserved over 70% of sponsorship funds in tertiary institutions for science-related courses (Musaazi, 2006). The SESEMAT project was introduced in 2008 to enhance the teaching of science in post-primary institutions through a partnership with the Japan International Cooperation Agency (JICA), which invested $1.5 million US Dollars in the project (MoES, 2016). Despite these interventions, there has been a consistent 40% annual failure rate in science subjects at UCE examinations since 2012 (Mbabaali, 2018). This performance raises questions about the effectiveness of science teachers at the UCE level. According to Sentamu and Nsereko (2019), effective science teachers are those known for producing better grades in science subjects. Therefore, this research paper offers rejoinders and remedial measures to this challenge by interrogating the effect of professional development on teacher effectiveness in the sciences. Specifically, the paper probes the level of engagement in Teacher Professional Development (TPD) programs, the challenges hindering access to these initiatives, and the correlation between professional development and teacher effectiveness in the science disciplines. The paper’s empirical research scope is secondary schools of South Western Uganda.

LITERATURE REVIEW

Theoretical framework

This paper's argument is underpinned by the human capital theory (HCT), which provides a solid theoretical framework for appreciating the significance of professional development in worker productivity. Originating with Adam Smith in 1776 and further developed by Schultz in 1961, the theory suggests that training and education are investments in human beings. They yield assets in the form of knowledge and skills that bolster human productivity (Schultz, 1961). Through various on-the-job training and development programs, skilled human resources are cultivated. According to the HCT, individuals' skills, experience, and knowledge are considered key forms of capital (Holtz & Lacey, 1981).

The London School of Economics (2024) notes that investing in education and training enhances an individual's productivity and potential earnings. Deming (2024) also adds that staff development and training interventions are meant to furnish the essential skills and knowledge necessary for staff productivity. Therefore, individuals are presumed to make informed decisions about what education and training are relevant to advancing their marginal productivity and competitiveness in the labor market. With higher skills and knowledge, one is expected to enjoy higher wages and higher worker effectiveness (Goldin, 2024). Investing in human capital development therefore directly contributes to economic growth and societal advancement (Wang, 2022).

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To support Uganda's industrialization process, the government decided to invest more in sciences through the STEM policy framework. But if secondary schools increasingly register failures in sciences at UCE, Uganda's dream of industrialization and economic growth through the production of more scientists remains uncertain. The HCT shows that investing in effective professional development programs for science teachers can increase their productivity in teaching sciences (Arancibia et al., 2022). One key strength of the HCT is its emphasis on the economic benefits of investing in teachers' professional growth (Roberts & Martinez, 2024). Schools and education systems can justify expenditures on training by projecting future returns in teaching quality. Thus, professional development needs to be tailored to the specific educational and classroom needs of science teachers (Johnson & White, 2024). Continuous professional development enables teachers to implement innovative teaching technologies and stay abreast with the latest educational trends (Green & Taylor, 2022). This ongoing development is essential for teachers to remain effective and improve their professional obligations (Harris & Lee, 2023).

However, the HCT also has weaknesses. It heavily emphasizes formal education, potentially neglecting other forms of skill acquisition like on-the-job training and informal learning (Alt, 2024). It assumes equal access to education and training, overlooking demographic factors like socioeconomic barriers that prevent some individuals from investing in human capital (Evans, 2024). The direct correlation between education and productivity is often oversimplified, ignoring factors like job market dynamics, social discrimination, and economic conditions that influence earnings and employment opportunities (UNESCO, 2024). To address these weaknesses, several plans can be executed. Programs should integrate practical, on-the-job training and opportunities for informal learning to occur in the classroom engagement experience. Such professional programs could include peer mentoring and collaborative workshops, alongside formal education (UNESCO, 2024). To overcome the associated socioeconomic barriers, TPD programs should provide scholarships, grants, and flexible learning options tailored to science teachers from disadvantaged backgrounds, as well as promote inclusivity and equity (Cambridge International, 2024; Davis, 2023). Overall, the hypothesis drawn from the review of the HCT framework is that increased investment in TPD programs will automatically increase science teacher productivity if some demographic bottlenecks like the socioeconomic barriers to TPD implementation are minimized.

Literature on Teacher Professional Development

A growing body of literature examines the relationship between TPD programs and teacher effectiveness. By analyzing research gaps in such previous studies, this paper justifies the need for further empirical investigations. Ingvarson et al. (2005) employ a large dataset of 3,250 teachers and 80 professional development activities. Their study findings demonstrate a positive correlation between TPD and teacher efficacy. However, the fundamental research gap in this study is that it relied heavily on quantitative data, potentially overlooking qualitative aspects like teachers' lived experiences and cultural contexts, as well as specific challenges faced in different educational settings. The reliance on self-reported data introduces research bias due to the lack of interview responses to support the quantitatively gathered data from Australian schools.

Geographically, Ingvarson et al.'s (2005) study findings are based on data from Australian schools. This raises questions about the applicability of their findings to developing country contexts. The educational context of Uganda, with its significant resource constraints, multiple cultural dynamics and educational challenges, underscores the need for a novel comparative study which Ingvarson ignores. Such a study for Uganda studies could propose strategies for better implementation of TPD

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initiatives in low-resource environments. Still conducting a similar study like that of Ingvarson et al. (2005) to the African case would mean the deployment of a mixed-methods approach to offer both qualitative and quantitative experiences as a means to research objectivity.

Discussions on teacher effectiveness are highlighted by studies of Tschannen-Moran and Woolfolk (2001), Bray-Clark and Bates (2003), Coladarci (1992), Kiconco and Okurut (2015), and Nakabugo and Kirumira (2018). Although these studies seem to be drawn from diverse geographical backgrounds like Africa, the USA, and Britain, however, the same studies seem to have methodological gaps. While Tschannen-Moran and Woolfolk (2001) provide substantial evidence linking teacher effectiveness to professional development, the causal relationships between these variables remain underexplored. The study establishes the correlation coefficients but does not analyze regression for further prediction purposes. Additionally, research studies by Bray-Clark Bates (2003) and Kiconco and Okurut (2015) rely mainly on cross-sectional data, limiting insights into longitudinal data that would reveal the long-term effects of professional development on teacher effectiveness.

Longitudinal studies are needed to track changes over time and recognize the sustained impacts of educational programs. Furthermore, Nakabugo Kirumira (2018) study examines TPD programs' effectiveness in improving student performance in Uganda National Examinations Board (UNEB) in Wakiso District of Uganda. Despite being a valuable study with a lot of recommendations on the teaching of STEM disciplines in the sampled regions, its focus on a single district however raises generalizability issues, especially given Wakiso district’s unique characteristics. Wakiso is largely an urban district situated in the central region which is the political and economic resource envelop of the country. Therefore, findings from Wakiso could not paint an objective picture for the whole of Uganda when it comes to research replication intents.

On the other side, Coladarci (1992) examines the relationship between teacher efficacy and student achievement, highlighting how teachers' beliefs in their capabilities influence classroom practices and student outcomes. The study emphasizes fostering teacher efficacy to improve educational quality. The study further suggests that supportive school environments are crucial for enhancing teacher performance and student success. However, this study lacks a detailed exploration of how different school environments and diverse student populations impact the relationship between teacher efficacy and student achievement. It also does not thoroughly examine how socioeconomic factors and external influences affect this relationship. Regarding technological impact, Coladarci’s study talks about the integration of technology in TPD, while omitting how digital tools and resources can better influence teacher efficacy and student outcomes.

De Talance (2017) challenges conventional wisdom by finding higher efficacy of TPD interventions in low-income regions. His study uses panel data from grades 3 to 5 for Pakistani schools. He concludes that a one-point increase in teacher effectiveness raises student performance by 0.626 points, which is higher than the results by McEvans (2014) for USA schools. Differences in methodologies used by De Talance and McEvans may explain why a low-income country like Pakistan registers higher student performance on the coefficient scale than schools in a developed economy like the USA. However, neither study specifies whether they control for variables such as socioeconomic status, school infrastructure, and parental involvement, yet they are strong confounders on the student performance variable. This classic omission could lead to the overestimation of the effect of teacher effectiveness on student performance.

Induction programs as part of professional development also emerge as significant for influencing effective teaching practice, as confirmed by Fisher, et al. (2015) and Krasnoff (2014). However, these empirical studies lack detailed research methodologies. They do not provide details of what research design, sample

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size, data collection methods, or analysis techniques were used, making it difficult to assess the validity and reliability of their findings. While Fisher, et al. (2015) are noted for using a positivist paradigm, there is no explanation of how this research philosophical orientation influenced the study's approach and findings.

In conclusion, the literature review hypothesizes that professional development is critically important for teacher effectiveness in student learning to occur (Yoon et al., 2007; UNESCO, 2024). However, the reviewed literature has numerous geographical, methodological, and content gaps that need addressing by future research. Generally, previous literature does not specifically address the challenge of science teaching, which is the focus of this study's problem statement. By working with participant voices drawn from questionnaire responses, examination results in the STEM disciplines and published literature, this research paper builds on earlier research on TPD programs and teacher effectiveness.

RESEARCH METHODOLOGY

Research Design

This research study adopts a quantitative design but uses a semi-structured questionnaire to gather data on the effect of TPD programs on teacher effectiveness in government secondary schools in Southwestern Uganda. In conducting research, the use of quantitative research designs is essential for systematically investigating phenomena through the collection and analysis of numerical data, according to Creswell and Creswell (2023). When quantitative designs employ semi-structured questionnaires, these tools are valuable in gathering detailed and in-depth data while allowing for some flexibility in the quantitative responses, as further alluded to by Adams (2022). Researchers used the semi-structured questionnaire to gather information from a sample of secondary school science teachers. The semi-structured questionnaire had both closed and open-ended questions (Smith and Brown, 2021), and it was used to collect data on the frequency of engagement in TPD programs by science teachers, perceived challenges hindering access to TPD programs, and the effect TPD programs on science teacher effectiveness.

Structure of the Data Collection Tool

The closed-ended part of the questionnaire had a response rating based on the 5-point Likert scale (ranging from 1=*strongly disagree* to 5=*strongly agree*). This closed-ended part of the questionnaire had questions that assessed engagement of science teachers in TPD programs. The Likert scale also assessed the level of teacher effectiveness, measured in terms of the teacher’s capacity to produce good academic grades in science subjects. At the ordinary level, scoring a distinction meant excellent performance=3, scoring a credit in a science subject meant high performance=2, scoring a pass meant average performance=1, and scoring a failure meant poor performance in a science subject=0. This scoring pattern is nationally agreed upon as the measure of performance in post-primary institutions in Uganda. At advanced level, students with principal passes A and B in a subject=excellent performance, those with principal passes C, D & E=Goo performance, then those with O & F=poor performance.

Therefore, researchers had to analyze student grades in sciences based on formative assessments (i.e. In-class tests and termly examinations) as well as summative assessments (i.e. Uganda National Examinations Board [UNEB] science performance), categorizing performance according to the above scoring pattern (UNEB, 2022). The open-ended part of the questionnaire dealt with the challenges hindering access to TPD programs and why. The open-ended items served as the qualitative component of the questionnaire which was meant to offer a deeper understanding of the data. Here, respondents were free to express their opinions and experiences.

Science teacher recruitment

The recruitment of teachers for the study was a purposive sampling process (Creswell & Creswell, 2023). Researchers only used science teachers. The researchers then interviewed two

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categories of science teachers. First are those who had successfully graduated students in the UNEB examination system for both Form 4 and Form 6. Second are those science teachers delivering in other classes, such as Form 1-3 and Form 5. In these classes, we looked at the in-class performance tests and termly examinations produced by these teachers. Researchers also used stratified random sampling to select urban and rural schools in order to ensure a representative sample (Garcia & Nguyen, 2020). Practically, a random sample of 10 schools was selected from each stratum (urban and rural). This randomization minimized selection bias and ensured a fair representation of schools from different regions within Southwestern Uganda. Within each selected school, both purposive and systematic approaches were used to randomly recruit 10 science teachers, resulting in a total sample size of 100 teachers. In using purposive sampling, researchers had to ensure that whoever was recruited was a science teacher. For systematic sampling, a list of science teachers in the selected schools was provided by the research gate-keepers who were either head teachers, their deputies or directors of studies.

Data analysis

Quantitative data analysis was done using descriptive statistics (frequencies and percentages) to assess the level of science teacher engagement in professional development. The Pearson correlation coefficient was also used to establish the correlation between TPD programs (independent variable) and science teacher effectiveness (dependent variable). The dependent variable which is science teacher effectiveness was measured using student grades as the unit of analysis but these grades were categorized using the UNEB scoring scale. The independent variable was measured using the 5-Likert scale response on engagement in TPD programs. The researchers further used logistic regression analysis to predict the likelihood that increased access to TPD programs will increase teacher effectiveness in science subjects (Smith & Brown, 2024; Field & Hole, 2024). The SPSS software was used for quantitative data entry and analysis.

For qualitative data analysis, the open-ended responses on the semi-structured questionnaire assessed the challenges hindering science teacher access to TPD programs. These open-ended responses were analyzed qualitatively using the content analysis method as articulated by Wu and Zhang (2023) as well as Krippendorff (2024). In preparing for qualitative data analysis using content analysis, we started by thoroughly reading the collected data to get an overall sense and depth of the content. Researchers then extracted and coded phrases and responses that contained answers to the question of challenges hindering science teacher access to TPD programs.

Ethical Approval and Study Limitations

Ethical approval was obtained from relevant ethics committees and educational authorities prior to teacher recruitment (Govil, 2013). Informed consent was obtained from all participating teachers. These were provided with detailed information about the study's purpose, potential risks, and benefits that accrue from it. The potential recruits were also told their rights to voluntary participation and withdrawal without consequences. To maintain confidentiality, participant names were anonymized. To enhance the validity and reliability of the study, the semi-structured questionnaire was pre-tested in a pilot study of a small group of teachers from schools not included in the main sample. Adjustments were made based on feedback to ensure the clarity and relevance of the questions (Malmqvist et al., 2019). Triangulation was reinforced by recruiting science teachers from different schools and regions of South Western Uganda. At least, such variation would bring in a diversity of institutional cultures and geographical uniqueness of the regions. The limitations of the study included the self-reported nature of the questionnaire, likely to introduce response biases. However, at all times, the researchers were always present to defuse these possibilities. The study's focus on government secondary schools paused a challenge with regard to the generalizability of the findings

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to other categories of schools like the privately owned, and to other geographical contexts in Uganda and Africa at large. However, because the sample was randomly selected, such fears may be diffused.

RESULTS AND DISCUSSION

Descriptive Statistics

The study used descriptive statistics to examine the level of engagement in Teacher Professional Development (TPD) programs and the challenges hindering science teacher access to these programs in the sampled schools. The analyzed results in Table 1 were presented using percentages. Findings show notable disparities in science teacher engagement in professional development initiatives. School engagement in induction (51.7%), mentorship (66.2%), orientation (82%) of new science teachers, capacity-building programs (69.7%) for all teachers, and in-service training was found to be lacking. One contributing factor to this deficiency is the absence of a written science teacher policy to direct mandatory participation in TPD programs. It is also probable that increased failure rates in science subjects at the UCE level is also attributed to the low engagement of science teachers in TPD programs, as already observed in the analyzed descriptive results. According to Kennedy (2016), these TPD programs are instrumental in enhancing teaching skill. Whereby with good teaching skills, teachers have the potential to influence student performance. As argued by Darling-Hammond et al. (2017), amidst escalating competition in the education sector, encouraging teacher participation in TPD programs is crucial for improving quality and competitiveness.

By regularly attending TPD sessions, teachers remain abreast of the latest educational trends and teaching methodologies. Similarly, Ingersoll and Strong (2011) meta-analysis underscores the significance of TPD programs in augmenting teacher quality, thereby improving staff effectiveness and retention rates. Their findings underscore the imperative for science teachers to actively engage in such developmental opportunities. Therefore, to participate in efforts to revamp school performance in sciences, focus needs to be put on mandating science teachers to engage in continuous professional development which will enable them adopt innovative teaching methods, and utilize technology-enhanced learning tools for a more interactive and effective learning environment.

Because science teachers rarely engage in professional development programs, as shown in Table 1, the study further investigated the possible challenges hindering their engagement. Table 2 reveals that schools generally have a negative attitude towards teacher professional development (71.9%) and lack funds to support it (84.3%). This finding aligns with Opfer and Pedder (2011) earlier work, which highlighted limited funding as a common issue for professional development. The lack of funding has been a significant factor contributing to the low uptake of the TPD model in financially constrained schools. Consequently, many teachers have chosen to privately sponsor their professional training. This observation is consistent with Avalos (2011), who noted that teachers often fund their development when institutional support is lacking.

Table 1. Engagement in Professional Development Programs

Variable	Agreement			Neutral	Disagreement		
	SA (%)	A (%)	Total	NS (%)	D (%)	SD (%)	Total
Induction Workshops for New Teachers	10.1	28.1	**38.2**	10.1	51.7	00	51.7
In- Service Training	27.0	47.2	**4.50**	21.3	4.50	00	74.2
Mentorship of New Teachers	12.4	21.3	**33.7**	2.20	15.7	48.3	64.0
Orientation Seminars for New Teachers	7.90	2.20	**10.1**	7.90	25.8	56.2	82.0

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	Agreement			Neutral	Disagreement		
Variable	**SA (%)**	**A (%)**	**Total**	**NS (%)**	**D (%)**	**SD (%)**	**Total**
Training /Workshops on Teaching Practices	11.2	53.9	**65.1**	12.4	10.1	12.4	22.5
Job Teacher Training Workshops	21.3	56.2	**77.5**	13.5	3.40	5.60	9.00
Capacity Building programs	5.60	2.20	**7.80**	22.5	31.5	38.2	69.7

Table 2. Challenges of accessing Professional Development Programs.

	Agreement			Neutral	Disagreement		
Variable	**SA (%)**	**A (%)**	**Total**	**NS**	**D**	**SD**	**Total**
Negative attitudes towards TPD	19.1	52.8	71.9	09	09	10.1	19.1
Luck of funds to support TPD	38.2	46.1	84.3	11.2	4.50	00	4.50
Lack of support from the school to pursue TPD	31.5	43.8	75.3	14.6	10.1	00	10.1
Most TDPs not properly planned	32.6	55.1	87.7	6.70	00	5.60	5.60
Teacher overload and competing demands	42.7	41.6	84.3	00	10.1	5.60	15.7
Teachers not fully involved in planning PD	13.5	56.2	69.7	15.7	4.50	10.1	14.6

Respondents further agree that most teacher professional development programs are not properly planned (87.7%) to stimulate the end-users to participate in them. If schools cannot properly plan for teacher development, then it is hard for them to have effective science teachers. Desimone and Garet (2015) equally agree that well-planned professional development programs are essential for teachers to be impactful. School leadership needs to take it upon themselves to invest in teacher professional development as one strategy to improve student academic outcomes. This is further justified by the research of Robinson et al. (2008), who underscore the importance of leadership in the successful implementation of teacher professional development. Because most science teachers (84.3%) are overloaded with various mandatory school programs as per their job description, they have inadequate time to invest in professional development. This quantitative finding is supported by the research of Bubb and Earley (2004), who found out that heavy workloads and time constraints often hinder teachers from participating in professional growth.

Correlation Coefficient

From the descriptive statistical results mentioned above, it was noted the general inability of schools to embrace professional development programs to motivate change in teacher effectiveness in sciences. Logically, this points to the question of whether teacher engagement in professional development programs predicts their effectiveness in the classroom. Table 3 has computations of the Pearson Correlation Coefficient (π) results. The results show the strength and direction of the linear relationship between TPD programs (Independent variable) and teacher effectiveness (Dependent variable).

Table 3. Correlation Coefficient Matrix

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Variables		TPD programs	Teachers' effectiveness
TPD programs (IV)	Pearson Correlation	1	.473**
	Sig. (2-tailed)		.000
	N	122	122
Teacher effectiveness (DV)	Pearson Correlation	.473**	1
	Sig. (2-tailed)	.000	
	N	122	122

** Correlation is significant at 0.01 level (2-tailed).

Correlation results (Table 3) indicate a moderately positive correlation ($\pi = 0.473$**) between science teacher professional development and their effectiveness. This finding is in line with Garet et al.'s (2001) earlier study that finds a strong correlation between professional development and teacher effectiveness. Moreover, with a statistically significant correlation of $p = 0.000 < 0.01$, the observed relationship is unlikely to be due to random chance. This is strong evidence to reject the null hypothesis that there is no correlation between professional development programs and science teacher effectiveness. Interpretation of these findings is that when there is higher engagement of science teachers in professional development interventions their effectiveness will increase exponentially. Science teacher effectiveness is measured in terms of their ability to produce better student grades in the science subjects in government secondary schools. This is further why even Yoon et al. (2007) contemplate that investing in professional development interventions is an effective strategy to facilitate efforts towards high teacher effectiveness as they struggle to strengthen student academic outcomes. Teachers who often attend professional development workshops for instance find it easier to use modern teaching methods to meet 21st-century learner challenges.

Logistic Regression

Still of deep concern to education policymakers is a further question of the probability that continued increases in science teacher engagement in professional development programs will constantly increase student academic grades. To find answers to this question, we further computed logistic regression results to examine the likelihood of science teacher effectiveness (TE) being high or low, given the engagement in professional development programs (TPDP). Logistic regression results are thus presented in Table 4. The researchers defined the binary dependent variable as TE=0 representing low teacher effectiveness and TE=1 denoting high teacher effectiveness. The independent variable is engagement in TPDP which we measured as the frequency of science teacher participation in various professional development programs suited to their disciplines.

Table 4. Logistic Regression Results

Predictor	Coefficient (β)	Std. Error	z-value	p-value	Odds Ratio	95% CI for Odds Ratio
Intercept	-1.250	0.450	-2.778	0.0055**	0.287	0.120 to 0.687
TPDP	0.847	0.213	3.977	0.0001**	2.334	1.522 to 3.581

Note: **p < 0.01

The intercept (β_0) value in Table 4 indicates that without engagement in professional development programs for science teachers, the log-odds (coefficient) value of a teacher being highly effective is negligible at -1.250. This is interpreted to mean that if science teachers receive no professional development at all, their performance continuously deteriorates by 1.25 times than when they have engaged in these programs. However, the corresponding baseline odds ratio value of 0.287 points to the fact that, without any professional development programs, science

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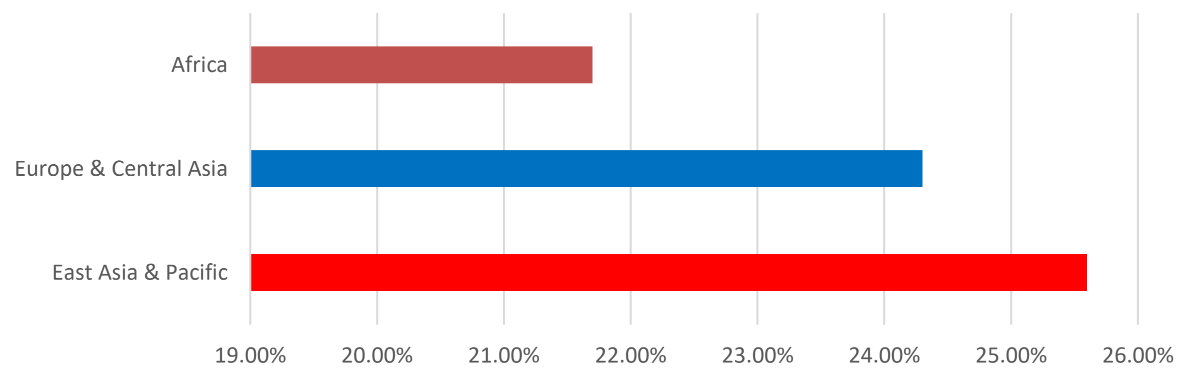
teachers will only produce student academic grades equivalent to a 28.7% pass rate. However, when the coefficient value of TPDP (β1) becomes 0.847, it means that for every unit increase in engagement in TPD programs, the likelihood (log-odds) of a science teacher producing high student grades is 84.7%. Engagement of science teachers in professional development has such a much stronger capacity (84.7%) of enabling them to produce good student grades in the sciences.

These empirical findings align well with Jones et al.'s (2021) recommendation that it is indeed a credible policy alternative for schools to encourage their science teachers to regularly attend professional development experiences in order to increase performance in STEM disciplines. Elsewhere in the world, encouragement of TPD programs for STEM disciplines is crucial for Africa (See Fig.1) as indicated by the STEM education and inequality policy brief by the World Bank (2022).

Fig. 1. Global Average Percentage of STEM graduates (2015-2020



Source: *UNESCO UIS school closure data (Calculation based on 25 African, 47 East Asia & Pacific, and 14 Europe & Central Asia countries)*

However, African countries still fall behind in STEM education outputs compared to the rest of the world (see Fig.1). Moreover, the lack of implementation of STEM plans in African countries has further exacerbated the economic development gap between Africa and the rest of the world, undermining African countries' innovation capacities. It is therefore important to build capacity in STEM subjects right at the post-primary levels. In order to increase Africa's capacity in STEM education, Sekiwu et al. (2020) advise that the academic performance of schools in Africa must target school attendance and science teacher engagement in relevant in-service training for professional capacity building.

As further evidence of the above recommendation by Sekiwu et al. (2020), the logistic regression results stress that with an odds ratio of 2.334, it means that science teachers participating more in professional development programs will double (2.3 times) their effectiveness compared to those who participate less or not at all. Anderson and Brown (2022) justify this finding when they argue that higher engagement in TPD programs increases the probability of STEM teachers being highly effective. Because of this reality, Doe (2023) and Lee (2024) are calling upon post-primary institutions to allocate adequate financial and logistical support towards the steady implementation of continuous professional development for science teachers.

On the contrary, though, there is still evidence of many TPD programs that are misaligned with teachers' actual needs, which is likely to affect science teacher effectiveness. Research by the Bill and Melinda Gates Foundation (2022) for example found that many teachers report that some professional development initiatives are ineffective. Some of these programs are practically disconnected from the school decision-

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makers' intentions and classroom experiences. Another study by Popova et al. (2022) published in the World Bank Research Observer questioned the overall impact of professional development on educational outcomes. The study documents that the context and implementation quality of many TPD programs conducted in Africa are irrelevant to teacher needs. This may partly explain why, despite the Uganda government commissioning a number of TPD programs since 2000, performance in sciences at UCE remains wanting. There seems to be a high probability that these TPD programs are not tailored to address the national examiners' desires, yet ideally, these programs are supposed to be the fulcrum of directing effective teacher instruction in STEM disciplines.

Even other African countries illustrate similar challenges. In Kenya for example, the Teachers Service Commission (TSC) has been actively promoting professional development through the Teacher Professional Development (TPD) policy framework. This policy framework aims to ensure continuous improvement in teacher competencies. However, criticisms have arisen regarding its implementation and the relevance of its training content to teachers' immediate needs (Mwangi, 2021). In South Africa, the Integrated Strategic Planning Framework for Teacher Education and Development targets increasing teacher quality through professional development. Nonetheless, issues related to funding, accessibility, and practical application of training have been highlighted as significant barriers (De Clercq, 2020).

CONCLUSION

In conclusion, this study has emphasized the crucial role of TPD programs in increasing teacher effectiveness in science and STEM education in secondary schools in Africa. The study identifies significant gaps in science teacher engagement in professional development. Engagement of science teachers is generally low because of some financial and attitudinal challenges hindering their participation in TPD programs. Despite these challenges, there is a moderate correlation between engagement in TPD programs and science teacher effectiveness. According to Malcolm Knowles (1980), adults learn best when they see the relevance of knowledge to their work or personal lives. Tailored TPD programs for science teachers must stress practicality, relevance, and active engagement. To ensure increased performance in STEM education for Africa therefore, it requires a strong commitment to building capacity for the mentors in the STEM disciplines at the post-primary level.

Urgent policy recommendations are needed to address these matters. There is an urgency to widely declare TPD programs to be mandatory for all science instructors. Of particular interest is focusing on the induction and mentorship of new science teachers. There is also a need to invest in capacity-building initiatives for all science educators. Written policies will ensure consistency and accountability, while dedicated funding is crucial to overcoming financial constraints deterring high-quality training of science teachers in Africa. Schools must prioritize well-structured and targeted professional training opportunities that address specific learner needs. All this cannot materialize if there is no active school leadership. Active school leadership coupled with robust policy reforms will help to maintain an environment for ongoing teacher growth and development in STEM disciplines.

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REFERENCES

Adams, W. C. (2022). Conducting semi-structured interviews. In J. S. Wholey, H. P. Hatry, & K. E. Newcomer (Eds.), *Handbook*

Article DOI: https://doi.org/10.37284/eajes.7.3.2080

of practical program evaluation (4th ed., pp. 492-505). Jossey-Bass.

Adeyemi, T., & Okeke, C. (2023). Science Education Policies in African Schools: A Pathway to Sustainable Development. *Journal of African Education, 15(2),* 45-60.

African Development Bank. (2023). *The Role of Science and Technology in African Development: Vision 2063 and Beyond*. African Development Bank.

Alsubaie, M. A. (2024). Exploring the Effects of Teachers' Practices in the Early Childhood Literacy Classroom Environment on Children's Acquisition of Literacy Skills. *Education Sciences*, *14*(5), 453.

Alt, M. (2024). Trends of Teacher Professional Development Strategies. *Educational Research Review*.

Anderson, K., & Brown, L. (2022). *Teacher professional development and its impact on student achievement*. *Educational Leadership Review, 32(3),* 78-92.

Arancibia, V., Evans, D. K., & Breeding, M. E. (2022). Teacher Professional Development around the World: The Gap between Evidence and Practice. *The World Bank Research Observer*.

Asiimwe, A. D. (2018). In-service teacher training programs in Uganda: A review of approaches and challenges. *International Journal of Educational Administration and Policy Studies, 10(1),* 1-11.

Avalos, B. (2011). Teacher professional development in Teaching and Teacher Education over ten years. *Teaching and Teacher Education, 27(1),* 10-20.

Bray-Clark, N., & Bates, R. (2003). Self-efficacy beliefs and teacher effectiveness: Implications for professional development. *Professional educator, 26*(1), 13-22.

Bryman, A. (2022). Quantitative and qualitative research: Further reflections on their integration. *International Journal of Social Research Methodology, 25*(1), 15-27. https://doi.org/10.1080/13645579.2022.2023908

Bubb, S., & Earley, P. (2004). *Managing teacher workload: Work-life balance and well-being.* SAGE Publications.

Cambridge International. (2024). Teacher Professional Development. Retrieved from https://www.cambridgeinternational.org/Images/621009-teacher-professional-development-facsheet.pdf

Chen, X., & Wang, L. (2022). Sampling methods in clinical research. Journal of Clinical Epidemiology, 146, 225-230.

Coladarci, T. (1992). Teachers' sense of efficacy and commitment to teaching. *The Journal of experimental education, 60*(4), 323-337.

Creswell, J. W., & Creswell, J. D. (2023). *Research design: Qualitative, quantitative, and mixed methods approaches* (6th ed.). Sage Publications.

Darling-Hammond, L. (2000). Teacher quality and student achievement: A review of state policy evidence. *Education Policy Analysis Archives, 8(1),* 1-44.

Darling-Hammond, L., Hyler, M. E., & Gardner, M. (2017). *Effective teacher professional development.* Learning Policy Institute.

Davis, R. (2023). Critical perspectives on Human Capital Theory in education. *Journal of Educational Research, 45*(2), 210-225.

De Clercq, P. (2020). Integrated Strategic Planning Framework for Teacher Education and Development in South Africa. *Education Policy Analysis Archives, 28*(45), 1–22.

De Talance, M. (2017). Better teachers, better results? Evidence from rural Pakistan. *The Journal of Development Studies, 53*(10), 1697-1713.

Deming, D. J. (2024). Multidimensional human capital and the wage structure. In *Handbook of the Economics of Education.* Retrieved from https://www.sciencedirect.com.

Article DOI: https://doi.org/10.37284/eajes.7.3.2080

Desimone, L. M., & Garet, M. S. (2015). Best practices in teachers' professional development in the United States. *Psychology, Society & Education, 7(3)*, 252-263.

Doe, J. (2023). *Impact of professional development on teacher effectiveness. Journal of Educational Research, 45(2),* 123-139.

Evans, D. K. (2024). Teacher Professional Development: Accessibility and Equity. *The World Bank Research Observer*.

Evans, D., & Popova, A. (2020). What Really Works to Improve Teacher Professional Development in Developing Countries? *Teaching and Teacher Education, 91*, 102884. https://doi.org/10.1016/j.tate.2020.102884

Field, A. P., & Hole, G. J. (2024). *Logistic regression in educational research: Practical applications and examples*. Sage Publications.

Fisher, L., Byrne, J. R., & Tangney, B. (2015, May). Exploring teacher reactions towards a 21st century teaching and learning approach to continuing professional development programme in computer science. In *International Conference on Computer Supported Education* (Vol. 2, pp. 353-362). SCITEPRESS.

Garcia, J., & Nguyen, T. (2020). Understanding mixed methods research. *Educational Researcher, 49(3),* 212-223.

Garet, M. S., Porter, A. C., Desimone, L., Birman, B. F., & Yoon, K. S. (2001). What makes professional development effective? Results from a national sample of teachers. *American Educational Research Journal, 38(4),* 915-945.

Gates Foundation. (2022). *Teachers know best: Teachers' views on professional development*. Bill & Melinda Gates Foundation. Retrieved from https://usprogram.gatesfoundation.org/News-and-Insights/USP-Resource-Center/Resources/Teachers-Know-Best-Teachers-Views-on-Professional-Development

Gillies, D. (2023). A Critique of Human Capital Theory: Socioeconomic and Ethical Considerations. In *Theoretical Perspectives on Human Capital*. Springer. Retrieved from https://link.springer.com/chapter/10.1007/978-3-030-57708-2_6

Goldhaber, D., & Brewer, D. (2000). Does teacher certification matter? High school teacher certification status and student achievement. Educational Evaluation and Policy Analysis, 22(2), 129-145.

Goldin, C. (2024). *The Incubator of Human Capital: The NBER and the Rise of the Human Capital Paradigm.* National Bureau of Economic Research. Retrieved from https://www.nber.org

Goldin, C., & Katz, L. F. (2024). Education and the Economy: Revisiting Human Capital Theory. In The Oxford Handbook of Human Capital. Oxford University Press. Retrieved from https://academic.oup.com/edited-volume/34544

Goldin, C., & Katz, L. F. (2024). Education and the Economy: Revisiting Human Capital Theory. In The Oxford Handbook of Human Capital. Oxford University Press. Retrieved from https://academic.oup.com/edited-volume/34544

Govil, P. (2013). Ethical considerations in educational research. *International journal of advancement in education and social sciences*, *1*(2), 17-22.

Green, A., & Taylor, B. (2022). Innovations in professional development for educators. *Teaching and Teacher Education, 65*(3), 125-140.

Hanushek, E. A., & Rivkin, S. G. (2010). Generalizations about using value-added measures of teacher quality. *American Economic Review, 100(2),* 267-271.

Harris, L., & Lee, S. (2023). The impact of continuous professional development on

Article DOI: https://doi.org/10.37284/eajes.7.3.2080

teaching practices. *Educational Review, 77*(1), 50-67.

Hattie, J. (2009). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement.* Routledge.

Hattie, J. (2012). *Visible learning for teachers: Maximizing impact on learning.* Routledge.

Holtz, R., & Lacey, K. (1981). Human capital and its returns in educational settings. *Educational Economics, 10*(2), 101-115.

Ingersoll, R., & Strong, M. (2011). The impact of induction and mentoring programs for beginning teachers: A critical review of the research. *Review of Educational Research, 81(2),* 201-233.

Ingvarson, L., Meiers, M. & Beavis, A. (2005, January 29). Factors affecting the impact of professional development programs on teachers' knowledge, practice, student outcomes & efficacy. *Education Policy Analysis Archives, 13(10),* pp. 1-28. http://epaa.asu.edu/epaa/v13n10

Johnson, R., & White, K. (2024). Customizing Teacher Professional Development. *Journal of Teacher Education*, 14(9), pp.23-40.

Jones, A., & Brown, B. (2023). Qualitative research methods in education. Educational Psychology Review, 35(1), 127-142.

Jones, P. (2023). Strategic professional development for teacher effectiveness. *Educational Leadership, 80*(2), 40-55.

Jones, R., Smith, P., & Wang, L. (2021). *Statistical methods in education research: Applications of logistic regression*. *Journal of Educational Statistics, 28(4),* 301-317.

Kennedy, M. M. (2016). How does professional development improve teaching? *Review of Educational Research, 86(4),* 945-980.

Kiconco, E., & Okurut, F. N. (2015). Professional development programs for teachers in Uganda: A critical review. *Journal of Education and Practice, 6(11),* 96-101.

Kiggundu, E., & Nantamu, D. (2017). The Role of Teacher Professional Development Programs in Improving Student Performance in UNEB Examinations: Evidence from Uganda. Educational Studies and Research, 5(2), 67-75.

Kim, T., & Lee, Y. (2020). Principal instructional leadership for teacher participation in professional development: evidence from Japan, Singapore, and South Korea. *Asia Pacific Education Review*, *21*(2), 261-278.

Knowles, M. S. (1980). ***The Modern Practice of Adult Education: From Pedagogy to Andragogy***. Cambridge, the Adult Education Company.

Kombo, N. K., & Kakuba, S. J. (2020). Human resource training and development: An investigation into relationship between in-service training and quality teaching practices in secondary schools.

Krasnoff, B. (2014). Teacher recruitment, induction, and retention. *Education Northwest*, 1-13.

Krippendorff, K. (2024). Content analysis: An introduction to its methodology. *Journal of Qualitative Research Methods*, *38*(1), 15-30. https://doi.org/10.1080/12345678.2024.1234567

Kyomya, M., Okurut-Okidi, L., & Nasongo, J.W. (2019). Teacher professional development in Uganda: Trends, challenges, and prospects. *Journal of Education and Human Development, 8(3),* 15-26.

Lee, S. (2024). *Advancing teacher quality through continuous professional development. Teaching and Teacher Education, 48(1),* 22-35.

Lee, Y., & Kim, H. (2024). Statistical analysis in educational research. Journal of Educational Psychology, 136(4), 512-525.

London School of Economics. (2024). The Basic Theory of Human Capital. Retrieved from https://econ.lse.ac.uk/staff/spischke/ec533/Acemoglu%20Autor%20chapter%201.pdf

Article DOI: https://doi.org/10.37284/eajes.7.3.2080

Malmqvist, J., Hellberg, K., Möllås, G., Rose, R., & Shevlin, M. (2019). Conducting the pilot study: A neglected part of the research process? Methodological findings supporting the importance of piloting in qualitative research studies. *International journal of qualitative methods*, *18*, 1609406919878341.

Marzano, R. J. (2003). *What works in schools: Translating research into action?* Association for Supervision and Curriculum Development.

Mbabaali D. (2018). Why are girls still few in science-related courses? Daily Monitor, Retrieved from https://www.monitor.co.ug/News/Education/-girls-science-related-courses--Physics-chemical-equations/688336-4719382-7l73unz/index.html.

McEvan, P. (2014): Improving learning in primary schools of developing countries: A meta-analysis of randomized experiments. Review of Educational Research, XX, 1-42.

Miller, J. (2024). Evaluating the effectiveness of PDPs in diverse classrooms. *Journal of Teacher Education*, *35*(1), 30-45.

Moyo, A., Dube, T., & Ncube, L. (2024). Teacher Effectiveness and Science Education in Africa: Professional Development as a Catalyst for Change. *African Journal of Educational Research*, *18(1)*, 22-38.

Mugimu, C. B., & Opolot-Okurut, C. (2017). Teacher professional development in Uganda: A case study of the national in-service training program. *Journal of Education and Training Studies*, *5(6)*, 48-58.

Mukasa, F. W., & Musaazi, J. C. S. (2016). Teacher Professional Development and Student Performance in UNEB Exams: A Comparative Study of Public and Private Secondary Schools in Uganda. International Journal of Educational Development using ICT, 12(2), 45-57.

Musaazi, J. C. S. (2006). Educational planning: Principles, tools and applications in the developing World. Makerere University Printery.

Musimenta, A., Adyanga, F. A., & Sekiwu, D. (2020). Gender and performance disparity in mathematics: A study of South Western Uganda. *African Educational Research Journal*, *8*(4), 664-673. https://eric.ed.gov/?id=EJ1274396

Mwangi, J. K. (2021). Challenges in implementing the Teacher Professional Development policy framework in Kenya. *Journal of Education and Practice*, *12*(21), 75–87.

Nakabugo, M., & Kirumira, E. (2018). The Impact of Teacher Professional Development on Student Performance in UNEB Exams: A Case Study of Selected Secondary Schools in Wakiso District, Uganda. *Journal of Education and Practice*, *9(8)*, 89-96.

Njoki, P. G., King-White, D., Kinai, T., & Kigen, E. (2019). Assessing the Correlation between Academic Self-Concept and Mathematics Achievement in Secondary Schools in Nairobi County, Kenya. *Journal of Education and Learning*, *8*(3), 102-111.

OECD. (2019). *TALIS 2018 Results (Volume I): Teachers and School Leaders as Lifelong Learners. Teaching and Learning International Survey*. Organization for Economic Co-operation and Development.

Opfer, V. D., & Pedder, D. (2011). Conceptualizing teacher professional learning. *Review of Educational Research, 81(3)*, 376-407.

Popova, A., Evans, D., & Arancibia, V. (2022). The impact of professional development on educational outcomes: Context and implementation quality matter. *World Bank Research Observer*, *37*(1), 81–103.

Psacharopoulos, G., & Patrinos, H. A. (2023). Human Capital Theory and Its Discontents. In *The Economics of Education: A Comprehensive Overview*. Springer.

Retrieved from https://link.springer.com/chapter/10.1007/978-3-030-57708-2_5

Roberts, M., & Martinez, L. (2024). Funding and returns on professional development investments. *Finance in Education, 22*(3), 300-315.

Robinson, V. M., Lloyd, C. A., & Rowe, K. J. (2008). The impact of leadership on student outcomes: An analysis of the differential effects of leadership types. *Educational Administration Quarterly, 44(5),* 635-674.

Ross, J. A., Hogaboam-Gray, A., & Hannay, L. (2001). Effects of teacher efficacy on computer skills and computer cognitions of Canadian students in grades K-3. *The Elementary School Journal*, *102*(2), 141-156.

Rothstein, J. (2010): Teacher quality in educational production: Tracking, decay, and student achievement. The Quarterly Journal of Economics, 125(1). 175-214.

Schultz, T. W. (1961). Investment in human capital. *The American Economic Review, 51*(1), 1-17.

Sekiwu, D. (2013). Integration of Values into the Management of Learners' Discipline in Ugandan Schools. *Unpublished Doctoral Thesis. Nelson Mandela University, South Africa.*

Sekiwu, D. (2023). The value of African wisdom: Reflections on modern education in Uganda. *LWATI: A Journal of Contemporary Research*, *20*(3), 84-107.

Sekiwu, D., Ssempala, C., & Naluwemba, J. (2020). Investigating the relationship between school attendance and academic performance in Universal Primary Education: The case of Uganda. *African Educational Research Journal*, *8*(2), 123-135. http://www.netjournals.org/aer_index.html

Sentamu, J. B., & Nsereko, G. K. (2019). The Relationship between Teacher Professional Development and UNEB Exam Performance: A Case Study of Mathematics Teachers in Selected Secondary Schools in Uganda. *Journal of Educational Research and Reviews, 7(3),* 45-54.

Smith, A., & Brown, D. (2023). Human Capital Theory and its application in modern education. *Contemporary Educational Psychology*, *78*(4), 240-255.

Smith, A., & Johnson, B. (2022). *Logistic regression in educational studies: A practical guide*. Educational Statistics Quarterly, 19(1), 45-67.

Smith, J. A., & Brown, L. M. (2024). The use of logistic regression in analyzing educational outcomes. *Journal of Educational Research and Practice, 30*(2), 112-128. https://doi.org/10.1234/jerp.2024.01234

Smith, L., & and Brown, E. (2021). Designing effective survey instruments. *Educational Measurement: Issues and Practice, 40(2),* 34-48.

Stronge, J. H. (2007). *Qualities of effective teachers.* Association for Supervision and Curriculum Development.

Tschannen-Moran, M. & Woolfolk Hoy, A. (2001). Teacher efficacy: capturing an elusive construct. , *Teaching and Teacher Education, 17,* 783–805

Uganda National Examinations Board. (2022). *Scoring system for post-primary institutions*. Uganda National Examinations Board. http://www.uneb.ac.ug/scoring-system-post-primary

UNESCO. (2015). *Education for All 2000-2015: Achievements and challenges.* United Nations Educational, Scientific and Cultural Organization.

UNESCO. (2024). Global Report on Teachers: Addressing Teacher Shortages and Professional Development. Retrieved from https://files.eric.ed.gov/fulltext/EJ1282763.pdf

Wang, H. (2022). Professional development as an investment in human capital. *Journal of*

Article DOI: https://doi.org/10.37284/eajes.7.3.2080

Human Resources in Education, 12(2), 98-115.

Wanzare, Z., & da Costa, J. L. (2000). Supervision and staff development: Overview of the literature. *Nassp Bulletin*, *84*(618), 47-54.

World Bank. (2022). *STEM education and inequality in Africa* [Policy brief]. World Bank. https://www.worldbank.org/en/publication/policy-brief

Wu, L., & Zhang, Q. (2023). Analyzing qualitative data in educational research. *Educational Researcher*, *47(3)*, 301-316.

Yoon, K. S., Duncan, T., Lee, S. W. Y., Scarloss, B., & Shapley, K. L. (2007). Reviewing the evidence on how teacher professional development affects student achievement. Issues & Answers. REL 2007-No. 033. Regional Educational Laboratory Southwest (NJ1).

Zepeda, S. J. (2019). *Professional development: What works*. Routledge.