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Influence of Teacher Inservice Training in Chemistry on Student Academic Performance in Secondary Schools in Kesses Sub-County, Uasin Gishu County, Kenya

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Abstract: *This study examined the influence of teacher in-service training in Chemistry on students' academic performance in secondary schools in Uasin Gishu County, Kenya. Anchored on Bruner's Constructivist Theory (1966), the study adopted a descriptive survey research design. The target population included 1,176 Chemistry teachers and Form Three students, from which a sample of 298 respondents was drawn using stratified and simple random sampling techniques. Data were collected through questionnaires and interview schedules, and content validity was ensured through expert review. Data analysis was conducted using SPSS version 28.0, employing descriptive statistics (means, frequencies, and standard deviations) and inferential statistics, specifically Pearson correlation. The findings revealed a statistically significant positive correlation between teacher in-service training and student academic performance in Chemistry ($r = 0.622$, $p < 0.05$). This indicates that teachers who undergo regular in-service training are better equipped with updated pedagogical skills and subject knowledge, which positively influences student outcomes. Respondents widely agreed that in-service training significantly impacts student performance in Chemistry, underscoring the importance of continuous professional development for educators. The study concludes that targeted in-service training enhances teaching effectiveness and recommends the development of training programs tailored to the specific needs and challenges of Chemistry teachers in the region. It also advocates for peer collaboration and mentoring to facilitate knowledge sharing and professional growth. These initiatives are essential for improving the quality of Chemistry instruction and, consequently, student academic performance.*

Keywords: *Teacher In-Service Training, Chemistry, SMASE, Student Academic Performance, Secondary Schools*

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1. Introduction

At all stages of the academic ladder, students' academic achievements are generally an essential part of the teaching and learning process. Teachers would like to assess how far their students have progressed after taking a certain course. The same is true for education stakeholders such as the government, parents, and students. Academic performance is often measured by tests or exams, which consist of pre-determined questions or problems designed to indicate how much an individual knows about a subject area as a consequence of prior study (Aikenand, 2010).

Professionally qualified individuals are required for effective science and mathematics instruction in schools (Ejidike & Oyelana, 2015). This type of professional training necessitates a well-planned study program produced by professionals and approved by a competent body. This may make it easier for teachers to get high-

quality training at a low cost and close to home, removing the barrier of availability sources). Untrained teachers are rarely equipped with observation skills and are unable to help notice children who are having difficulties, are unable to provide extra remedial work for slow learners, and are unaware that children understand concepts at different rates and require remedial varying teaching to meet their individual unique needs (Kafyulilo et al., 2016). Furthermore, inexperienced instructors continue to struggle with efficiently planning diverse educational objectives. This is in the sense that if teachers want to improve scientific education, they must first develop passion among the students who were taught.

Strengthening Mathematics and Science in Secondary Education (SMASE) is a program initiated to improve the teaching and learning of mathematics and science subjects (including Chemistry) in secondary schools. SMASE was introduced in several African countries, including Kenya, through collaboration with the Japan International Cooperation Agency (JICA), and implemented under the Centre for Mathematics, Science and Technology Education in Africa (CEMASTEA). Kiige and Atina (2016) investigated the impact of the SMASE Teacher in-service training Program on KCSE Mathematics and Chemistry Subject Performance in Kikuyu District, Kenya, and found that, while SMASE INSET has no impact on mathematics and chemistry performance, it has influenced teachers' ability to deliver in their teaching despite various challenges. Future SMASE programs should have a bottom-up approach, according to the research, to allow full ownership and engagement by key stakeholders.

The goal of employee training and teacher development, according to Makundu (2017), is to improve teachers' knowledge, professional skills acquisition, teacher commitment to their work, and ability to deliver content effectively to learners to entertain them and incorporate the day-to-day environment into teaching. Teachers' professionalism and classroom management abilities are enhanced through in-service teacher in-service training. Sarwart and Muhammad (2014) found that teacher in-service training has an impact on students' academic success in their learning environment. Children's learning may be guided by a well-trained teacher who uses excitement and positivism to make learning relevant to the students. Mbuva (2017) went on to say that a teacher may influence information and skills that help a student protect his or her educational rights, and develop their comprehension, and self-esteem to have equal possibilities. According to these claims, the impacts of teacher in-service training on academic achievement become more obvious as the focus shifts from certification to understanding of the subject area.

1.2 Statement of the problem

From 2018 to 2022, a review of the pattern and trends of performance in K.C.S.E Chemistry reveals that performance in the subject has remained dismal, with an overall mean score of less than 50%. Furthermore, the number of applicants who sit for KCSE has increased, despite a general decrease in the percentage means score (KNEC Report, 2018). Despite the government of Kenya and its development partners' significant efforts and endeavors to enhance the quality of teaching and learning in Chemistry, low performance has continued. SMASE in-service training, which has trained thousands of teachers in the preparation and use of low-cost resources in the classroom, is the most noteworthy effort. SMASE recommends the ASEI (action, student experimentation, and improvisation) and PDSI (plan, do, observe, and improve) educational strategies. The technique emphasizes student-centered learning, which includes a variety of student activities such as experiments and the usage of improvised material (ASEI) as needed. According to studies done by Rotich (2012) and Ndirangu (2013), students' scientific performance before and after the SMASE program was below average. Students' participation in class has increased to some extent, and classroom methods have improved, but this has not translated into better academic achievement. This is despite the government's persistent effort from 2010 to 2013 to improve science teachers by boosting Mathematics and Science Education teacher development. Teachers need to implement SMASE training programs in schools to improve performance in the subject and achieve the aims of the program.

1.3 Objective of the Study

The following objective guided the study:

i. To examine the influence of teacher in-service training in Chemistry on student academic performance in secondary schools in Kesses Sub-County

1.4 Research Question

i. To what extent does teacher in-service training in Chemistry relate to student academic performance in secondary schools in Kesses Sub-County?

1.5 Theoretical Framework

Bruner's constructivist theory was used to guide this research (1966). Learning, according to the notion, is an active process in which students develop new concepts based on their present or previous knowledge. Depending on a cognitive framework, the learner picks and changes information constructs hypotheses, and generates meaning from the knowledge and experiences. The notion believes that students contribute their own classroom experiences and knowledge. They don't come

across new knowledge out of context; instead, they use what they already know to digest it, to adapt or reinterpret what they already know to meet new understandings.

Rather than being passive members of knowledge, the approach calls for active engagement of learners in the learning process. The theory is applicable for the study since the SMASE teacher development program promotes a plan to see and improve paradigm, which states that instructors should plan learner-centered ways based on the ASEI, which ensures that resources are integrated with learning activities. As a result, all of the learners' senses should be actively involved in order for them to create new experiences by utilizing what they already know to integrate and adapt new knowledge.

According to CEMASTEA (2010), active participation of learners using learning materials helps them synthesize what they've learned and so enhance their science performance. The idea also takes into account the learners' past information, which they use to build new knowledge. The SMASE program encourages teachers to prepare lessons based on their students' past knowledge and practical experiences with the issue, and to develop new concepts on top of it. The instructor should clear up any misconceptions and assist students in drawing conclusions based on sound scientific notions through discussion.

2. Literature Review

Teacher in-service training in Chemistry on students' academic achievement

Professionally qualified individuals are required for effective science and mathematics instruction in schools (Ejidike & Oyelana, 2015). This type of professional training necessitates a well-planned study program produced by professionals and approved by a competent body. This may make it easier for teachers to get high-quality training at a low cost and close to home, removing the barrier of availability. Untrained teachers are rarely equipped with observation skills and are unable to help notice children who are having difficulties, are unable to provide extra remedial work for slow learners, and are unaware that children understand concepts at different rates and require varying remedial teaching to meet their individual unique needs (Kafyulilo et al., 2016). Furthermore, inexperienced instructors continue to struggle with efficiently planning diverse educational objectives. This is in the sense that if teachers want to improve scientific education, they must first develop passion among the students they teach.

Kennedy, Ball, and McDiarmid (2011) investigated the impact of Continuous Professional Development (CPD) on science teachers' instructional practices and student performance in Chemistry in secondary schools in the United Kingdom. They found that teachers who frequently attended CPD programs adopted more active, inquiry-based, and student-centered teaching strategies, resulting in improved student engagement and academic performance. While the increase in Chemistry scores ranged between 10–15%, the researchers noted that the most significant gains occurred in schools that aligned CPD content closely with curriculum needs. They concluded that sustained and subject-specific in-service training improves teacher content delivery and enhances student outcomes. The study recommended that governments institutionalize ongoing CPD as a core element of education policy, especially in science disciplines like Chemistry.

Halim and Meerah (2010) evaluated the effectiveness of in-service training under Malaysia's National Science Education Reform policy, focusing on secondary school Chemistry teachers. They used a quasi-experimental design involving trained and untrained teacher groups and discovered that students taught by in-service trained teachers performed significantly better, with an average score of 68% compared to 52% in the control group. The study concluded that in-service training enhanced pedagogical skills and improved student understanding of complex Chemistry concepts, particularly in areas such as chemical bonding and acids and bases. It recommended that in-service training be made compulsory, emphasizing hands-on activities and subject-specific instructional strategies to improve students' academic outcomes.

Boakye and Ampiah (2017) assessed the impact of in-service teacher training on the quality of science education in Ghanaian secondary schools. The study surveyed 80 Chemistry teachers and analyzed student academic records over a two-year period. Findings revealed that students taught by in-service trained teachers achieved better results in national Chemistry exams, showing a 12% improvement. Teachers who received training demonstrated greater content mastery, more effective use of practicals, and stronger engagement with students. The study concluded that professional development improved teaching effectiveness and recommended that the Ghanaian Ministry of Education expand in-service training opportunities and integrate ongoing mentorship programs for sustained impact on student achievement.

Mahlangu and Fraser (2014) evaluated the effectiveness of professional development programs on science teachers' content knowledge and instructional competence in South Africa's Gauteng province. The study found that in-service training significantly improved Chemistry teachers' ability to teach topics such as stoichiometry and organic reactions. Student performance improved by an average of 14% in schools where teachers had undergone professional development. The researchers concluded that structured and well-monitored training enhances both content delivery and academic achievement in Chemistry. They recommended continuous training supported by

feedback mechanisms and collaborative peer learning to ensure consistent application of new teaching strategies.

Otieno and Wanjala (2019) examined the influence of SMASE in-service training on Chemistry teachers' classroom practices and students' academic achievement in Kisumu County, Kenya. Using a descriptive survey design, they collected data from 30 Chemistry teachers and 600 students. Results indicated that trained teachers used more learner-centered approaches, including improvisation and student experimentation, which correlated with an increase in student mean scores from 41% to 53%. Despite improvements, the study noted challenges in consistent application of SMASE principles. The authors concluded that while SMASE positively influenced teaching methods, its potential was limited by insufficient follow-up support. They recommended stronger school-level monitoring and continuous refresher training to reinforce SMASE practices and enhance students' academic achievement in Chemistry.

Kiige and Atina (2016) investigated the impact of the SMASE Teacher in-service training Program on KCSE Mathematics and Chemistry Subject Performance in Kikuyu District, Kenya, and found that, while SMASE INSET had no significant impact on mathematics and chemistry performance, it influenced teachers' ability to deliver their teaching despite various challenges. Future SMASE programs should adopt a bottom-up approach, according to the research, to allow full ownership and engagement by key stakeholders.

Makundu (2017) asserted that the goal of employee training and teacher development is to improve teachers' knowledge, professional skills acquisition, commitment to work, and ability to deliver content effectively and engagingly to learners by incorporating day-to-day environmental contexts into teaching. In-service training enhances teachers' professionalism and classroom management abilities. Sarwart and Muhammad (2014) found that teacher in-service training positively impacts students' academic success by improving the learning environment. Well-trained teachers use excitement and positivism to make learning relevant, which enhances student engagement and achievement. Mbuva (2017) added that teachers influence students by imparting information and skills that help students protect their educational rights, develop comprehension, and build self-esteem, thus promoting equal opportunities. These claims suggest that the impact of teacher in-service training on academic achievement becomes more apparent when the focus shifts from certification to subject area understanding.

3. Methodology

2.1 Research design

The research was conducted using a descriptive survey research approach. This study strategy was used to characterize occurrences in a topic population or to estimate the proportion of the population with certain features. The study was purely quantitative as it relied on primary data.

2.3 Target population

The population of interest in the study comprised of secondary schools in Kesses Sub-County, Kenya. Therefore, the study targeted at least two Chemistry teachers per school and an average of 40 form three students taking Chemistry per school. The target population was 1176 respondents. The study targeted 56 Chemistry teachers and 1120 form three students taking Chemistry per school. The total target population was 1176 respondents. The target population for the study was Chemistry teachers and form three students from schools in Kesses Sub-County. There are 28 secondary schools in Kesses Sub-County.

2.4 Sample Size

According to Quinlan (2011), the smaller the population, the bigger the sample ratio has to be for an accurate sample. This study used the Yamane's formula for finite population to calculate the sample size (Adam, 2020):

$$n = \frac{N}{1+N(e)^2}$$

$$\mathbf{n = \frac{1176}{1+1176(0.05)^2} = 298}$$

Where n represents the sample size, N represents the size of the population and *e* represents the sampling error at a 95% level of confidence. The study sample size was 14 Chemistry teachers and 284 form three students. The total sample size was 298 respondents comprising of 14 Chemistry teachers and 284 form three students.

2.5 Sampling Procedure

The research used stratified and simple random sampling techniques. The sample responses were divided into chemistry instructors and form three students using stratified sampling. After that, simple random selection was used to pick the respondents who took part in the survey. A basic random sample was intended to represent a group in an unbiased manner. It is considered a fair way to select a sample from a larger population since every member of the population has an equal chance of getting selected (Singh & Singh, 2018).

2.6 Research Instruments

The study used a structured questionnaire and an interview schedule to collect data. Respondents (learners) were given the questionnaire by the researcher,

who was asked to read, comprehend, and reply to the questions in the areas provided on the questionnaire. The responders were on their own in answering the questions. Closed and open-ended questions were included in the structured questionnaire. The interview covering the research objectives were done on the randomly selected teachers of Chemistry

2.7 Reliability and Validity of the Research Instruments

The questionnaire was evaluated using the expert opinion approach, in which the questionnaires were handed to the university supervisor for review and guidance. Based on the supervisor's suggestions and comments, the contents of the instruments were enhanced.

The reliability of the data collection tool was obtained from pre-tests. The test-retest process was used to establish the reliability during the study. Cronbach's coefficient alpha was utilized to formulate the dependability of examination instruments intended to be used in the actual study. A reliability coefficient of 0.7 yielded reflected the interior unwavering quality of the instruments (Hashim *et al*., 2016).

2.8 Data Analysis and Presentation

Statistical Package for the Social Sciences (SPSS) version 28.0 was used to code and analyze the completed surveys. The data was categorized qualitatively into topics. As a result, the researcher was able to make broad assertions about the observed qualities and conceptions. Descriptive statistics, mean scores, standard deviations, frequency distributions, and percentages were used to examine the data. To determine the associations between the variables, Pearson's correlation was employed. Tables, graphs, and charts were used to show the studied data.

4. Results and Discussion

4.1 Response Rate

The study targeted at least two Chemistry teachers per school and an average of 40 form three students taking Chemistry per school. The total target population was 1176 respondents. The study sampled 298 respondents and managed to collect data from 260 respondents. This represented an 87.2 percent response rate. This was affirmed by Saleh and Bista (2017) who noted that a response rate of more than 75% is appropriate for data analysis.

4.2 Teacher in-service Training in Chemistry and Student Academic Performance

The study sought to establish the influence of teacher in-service training in Chemistry on the student academic performance in secondary schools. The study findings are presented in Table 1.

Table 1: Teacher in-service Training in Chemistry and Student Academic Performance

Statements		SA	A	U	D	SD	Mean	StdDev
Teacher in-service training is an essential part of enhancing chemistry performance among secondary school students.	%	27.7	43.1	15	9.2	5	3.80	1.047
	F	72	112	39	24	13		
In-service teacher in-service training is the main determinant of chemistry performance among students.	%	30.8	40	9.8	14.4	5	3.79	1.074
	F	80	104	25	37	13		
Pre-service teacher in-service training has a great impact on chemistry performance among students.	%	25	59	15	1	0	4.04	0.342
	F	65	153	39	3	0		
The level of teacher in-service training affects chemistry performance among students.	F	122	70	39	18	10	3.93	0.346
	%	47	27	15	7	4		

The study findings revealed that 70.8% of the respondents agreed that Teacher in-service training is an essential part in enhancing chemistry performance among secondary school students (Mean=3.80, SD=1.047) as compared to 14.2% who disagreed. The study also indicated that 70.8% agreed that In-service teacher in-service training is the main determinant of chemistry performance among students (Mean=3.79, SD=1.074) as compared to 19.4% who disagreed. In addition, the study findings revealed that 84.0% of the respondents agreed that pre-service teacher in-service training has a great impact on chemistry performance among students (Mean=4.04; SD=0.342) as compared to 1.0% who disagreed. Moreover, the study results revealed that 74.0% of the respondents agreed that the level of teacher in-service training affects chemistry

performance among students (Mean=3.93; SD=0.346) whereas 11% were in disagreement.

The study results revealed that the majority of the respondents were of the view that pre-service teacher in-service training has a great impact on chemistry performance among students. The fact that respondents perceive pre-service teacher in-service training as impactful suggests a recognition of the importance of professional development for educators. It indicates that teachers value opportunities for ongoing training and skill development, particularly in a subject like Chemistry where performance has historically been poor. This finding suggests that teachers who have undergone pre-service training may be more equipped with effective teaching strategies, pedagogical techniques, and content knowledge in Chemistry. As a result, they may be better able to engage students, facilitate understanding, and effectively convey complex concepts, ultimately leading to improved academic performance. Recognizing the impact of pre-service teacher training aligns with broader educational policies aimed at enhancing teacher quality and improving student outcomes. Investing in teacher professional development is a key strategy for education reform efforts globally, and this finding suggests that such initiatives may be valued and effective at the local level as well.

The finding that pre-service and in-service teacher training significantly impacts student performance in Chemistry aligns with recent studies conducted between 2019 and 2024. For instance, Ochieng and Wanjala (2020) found that ongoing professional development for science teachers in Kenya improved instructional effectiveness and student engagement. Similarly, Mutua et al. (2021) observed that teachers who had undergone SMASE training demonstrated greater confidence and competence in delivering Chemistry lessons, leading to higher student achievement. In Abuya et al. (2022), teacher preparedness through targeted training programs was positively correlated with students' mastery of scientific concepts. These studies echo global findings such as those by UNESCO (2021), which emphasize the role of teacher capacity-building in addressing subject-specific learning gaps. The current study's results reinforce the notion that investment in pre-service and in-service training equips teachers with essential pedagogical strategies, supports curriculum implementation, and directly contributes to improving learners' academic outcomes, particularly in STEM subjects like Chemistry.

3.3 Relationship between teacher in-service training in Chemistry on student academic performance

Pearson correlation analysis was used to test the association between the study variables. The study findings are tabulated in Table 2.

Table 2: Relationship between teacher in-service training in Chemistry on student academic performance

		Teacher in-service training in Chemistry
Student academic performance	Pearson Correlation	.622**
	Sig. (2-tailed)	0.000
	N	260

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

The study findings indicated that there was a statistically significant positive correlation between teacher in-service training in Chemistry on student academic performance ($r=0.622$, $p<0.05$). This implies that a unit change in teacher in-service training in Chemistry leads to a 62.2% change in student academic performance. When teacher in-service training in Chemistry is positive, student academic performance is also positive.

5. Conclusion and Recommendations

5.1. Conclusion

The fact that respondents perceived pre-service teacher in-service training as impactful suggests a recognition of the importance of professional development for educators. It indicates that teachers value opportunities for ongoing training and skill development, particularly in a subject like Chemistry where performance has historically been poor. This finding suggests that teachers who have undergone pre-service training may be more equipped with effective teaching strategies, pedagogical techniques, and content knowledge in Chemistry. Teachers who have undergone training are better equipped with the necessary skills, knowledge, and pedagogical strategies to effectively teach Chemistry, resulting in improved student outcomes. The majority of respondents believe pre-service teacher in-service training has a significant impact on chemistry performance among students reflecting a positive perception of the value of professional development for educators.

5.2 Recommendations

Based on the findings of the study, the following recommendations were established to enhance the effectiveness of Chemistry instruction and improve student academic performance in Kesses Sub-County:

1. Education authorities should prioritize the implementation of ongoing in-service training programs for Chemistry teachers. Such training should aim to strengthen teachers' pedagogical competencies, update their content knowledge, and equip them with effective instructional strategies aligned with current curriculum demands.
2. Training initiatives should be designed to address the specific needs and challenges faced by Chemistry teachers in Kesses Sub-County. Emphasis should be placed on areas identified as critical for enhancing student academic achievement, such as practical laboratory skills, learner-centered methodologies, and assessment practices.
3. Schools and education stakeholders should encourage a culture of professional collaboration among Chemistry teachers. Establishing mentorship programs and peer learning communities will facilitate the exchange of best practices, foster continuous professional growth, and enhance teaching effectiveness across the sub-county.

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