



# Preparation to teach science in Kenya's primary schools

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## Abstract

This study determined Primary Teacher Education (PTE) Trainees' perceptions regarding their conceptual understanding of science subject content and Science Process Skills (SPS). The study further determined trainees' opinion regarding teaching of science in primary schools. A descriptive survey research design was used and stratified proportionate random sampling technique was used to select 131 trainees from science and 169 trainees from arts options. The study found out that overall trainees rated their conceptual understanding of science content and SPS to be average. More trainees in the science option than in the arts option rated their conceptual understanding of science content and SPS to be high and further indicated that subject specialization was necessary and only those trainees who specialize in science should teach science in primary school. They also indicated they would opt to teach science during training and after training. Hence trainees specializing in science were more prepared to teach science than trainees specializing in arts subject. The study recommends that subject specialization be abolished in PTE or teachers who specialize in science during training teach science in primary schools.

**Keywords:** Teacher education, Science teaching, Primary schools, Science Process Skills (SPS), Kenya

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## **1. Introduction**

Kenya as a country is committed to providing holistic quality education and training that leads to development of learners' cognitive domain (Republic of Kenya, 2012). This can be realized through teaching of the various school subjects and hence science education has critical role to play in achieving this goal. The role of science in promoting development of learners' cognitive domain can only be realized if science education would put more effort towards development of Science Process Skills (SPS) among learners as opposed to mere acquisition of scientific knowledge.

Kenya as a country as spelt out her development objectives in her Vision 2030 development strategy. Education has been identified as one of the pillars to assist Kenya to achieve this development vision. For science education to meet the aspiration of Vision 2030 (Kenya's Development Blueprint), there is a need to ensure that learners are well grounded with SPS. Republic of Kenya (2012) alludes that for Kenya to achieve her aspirations as enshrined in Vision 2030, SPS cannot be wished away by the school curricula. Hence school curricula should ensure that learners are well grounded with SPS. This can only be achieved if teachers also have high mastery of SPS, which could be delegate to the initial training of primary school teachers and in-service training for practicing teachers.

Towards this end learners should be empowered to do science through application of inquiry skills (SPS). The long-term effect of learners acquiring SPS is that they will be able to create scientific knowledge through application of the scientific process (Karsili and Sahin, 2009). If learners can create scientific knowledge using SPS, they can transfer this knowledge and apply it later in life. PTE trainees therefore, should have the capacity to inculcate SPS to their learners. To ensure PTE plays her role as far as training of science teachers is concerned, it should focus on how scientific knowledge is acquired other than transmission of scientific knowledge as a group of facts collected offer time. Teacher trainees in PTE should be trained on how to design scientific activities that can be used by primary school children to create their own scientific knowledge. However, in examination-oriented learning set ups like in the Kenyan education system, the focus is on rote learning for the purpose of passing examinations, which is a great impediment to learners' acquisition of SPS.

Teachers who are not well grounded with SPS tend to possess misconceptions of scientific knowledge (Deborah and Williamson, n.d.). Such teachers normally would transmit scientific knowledge to learners as group of fact that should not be altered and without interrogating its validity. This introduces the risk of passing their own misconceptions to their learners where learners will believe there is nothing new to be discovered since scientific knowledge already exists. The teachers may also accommodating pupils' own misconceptions instead of guiding them to undertake scientific activities that provoke them to check the authenticity of their own scientific knowledge. It is therefore clear that the teaching practices exercised by individual science teachers are a product of their conception of the nature of scientific knowledge and how scientific knowledge is acquired. According to Nyakiti et al. (2010), those teachers who view scientific knowledge as being static will tend to apply expository teaching approaches, which are counter-productive in development of SPS among pupils. On the contrary, those who hold the view that scientific knowledge is

dynamic will involve learners in scientific activities (experiments) and in the process the learners would create their own scientific knowledge and acquire SPS.

Thus if a teacher is not adequately ground with science subject content and Science SPS, he/she may be termed as ill prepared as a science teacher and may not effectively teach science. To this end, Li and Klahr (2006) observe that the main objective of science education is to teach children about accumulated knowledge of the natural world and to help them use methods, procedures and reasoning processes (SPS) to discover scientific knowledge.

In Kenya, the PTE science syllabus has given due emphasizes to mastery of science content matter and acquisition of science process skills by trainees (KIE, 2002). That notwithstanding, Kerre (2008) observes that PTE faces challenges because Kenya's PTE trainees have a very weak background in science content. Further, the PTE curriculum is also general in nature. This state of affairs suggests that PTE trainees may face challenges in teaching of science in primary schools. In countries like Kenya where primary education is terminal for some pupils, there is more need for teachers to be capable of imparting SPS to the pupils so that they can be functional in their societies even if they terminate their education at primary level of education.

In the current study, PTE trainees' perceptions regarding their conceptual understanding of science content and SPS were investigated. The findings of this study were used to generate discussion on preparedness of PTE trainees to teach science in primary schools in Kenya.

## 2. Materials and methods

Descriptive survey design was used in this study. According to Mugenda and Mugenda (2003), descriptive survey does not manipulate variables. This design was used to determine PTE Trainees' perceptions regarding conceptual understanding of science subject content, SPS and willingness to teach science by PTE trainees. It was further used to evaluate PTE trainees' opinion regarding whether subject specialization is necessary and who should teach science based on subject specialization in primary schools. All the PTE trainees had already been exposed to the whole PTE curriculum where one group had specialized in science and another one had specialized in arts in their second year.

### 2.1. Population

The target population was all the 2014 (Science option 991 and Arts option 1023) PTE trainees in the 5 public Primary Teachers Training Colleges (PTTCs) in the Rift Valley Zone in Kenya. Trainees were relatively homogeneous in terms of entry behaviour and gender.

### 2.2. Sampling procedures and sample size

Stratified proportionate random sampling techniques were used for trainees selection from science and arts option. Stratified sampling procedure ensures that the sample is representative of the population in terms of factors used for stratification (Fraenkel and Wallen, 2000). Stratified proportionate sampling ensured that

the elements selected from each group were in the same proportion of the groups in the target population. Records from the five PTTCs in the Rift Valley Zone indicate that there were a total of 991 and 1024 trainees in science option and arts option respectively. Thus the accessible population in this study was 2014 trainees.

To calculate the sample size, Mugenda and Mugenda (2013) recommends the formula:

$$nf = \frac{n}{1 + \frac{n-1}{N}}$$

based on this formula:

nf= desired sample size when the population is less than 10,000,

n= desired sample when the population is more than 10,000,

N= estimate of the population size.

This formula was applied as follow:

$$nf = \frac{384}{1 + \frac{384-1}{2014}} = 322 \text{ PTE trainees}$$

Finally, 300 (85.7%) trainees participated in the study.

### 2.3. Instrumentation

Data collection was through a paper and pencil survey, the Primary Teacher Trainees Questionnaire (PTTQ), which was developed by the researcher and comprised 9 structured open and closed ended questions. Trainees' opinions were categorized according to the selected/given responses. Percentages of the opinions, which trainees selected or volunteered, were calculated.

### 2.4. Data collection

The researcher trained one research assistant from each PTTC who assisted in administration of the invigilation and instruments. The researcher visited the five PTTC and was assisted by the research assistants to administer the questionnaire to the trainees in similar settings. This was to ensure a high return rate.

### 2.5. Data analysis

Data generated by PTTQ was tabulated according to the opinions selected/given by the respondents. The data was described by frequencies and percentages. Descriptive statistics enabled the researcher to meaningfully organize, describe and summarize the data (Mugenda and Mugenda, 2003; Fain, 1999).

### 3. Results and discussion

The main findings of the study are reported below under four themes namely: conceptual understanding of science content, conceptual understanding of science process skills, trainees willingness to teach science and trainees opinions on teaching of science and subject specialization

#### 3.1. Conceptual understanding of science content

The results on trainees' opinions on their level of conceptual understanding of science subjects studied in secondary school revealed that majority of the trainees in both science and arts option indicated that their conceptual understand was average (44.0%) and (46.3%) respectively. However, more trainees in science option (34.3%) than in arts option (22.6%) rated their conceptual understanding to be high (see Table 1).

**Table 1.** Level of Conceptualization of Secondary School Science Subjects According to subject Specialization (N=300)

Groups		No Response	High	Average	Low	Total
Option	Science	27	58	74	9	168
		16.2%	34.3%	44.0%	5.5%	56.0%
	Arts	27	30	61	14	132
		21.1%	22.6%	46.3%	10.7%	44.0%
Total		54	88	135	23	300
		18%	29.3%	45.0%	7.7%	100%

The studies further investigated trainees' opinion regarding their conceptual understanding of the science content studied in PTE. The results revealed that majority of the trainees in the arts option rated their conceptual understanding of PTE science to be average (57.3%) while majority of the trainees in science option rated theirs to be high (56.8%). Only 26.9% of the trainees in the arts option rated their level of conceptual understanding of the PTE science content to be high (see Table 2).

**Table 2.** Conceptualization of Science Content in the PTE Science Syllabus According to Subject Specialization (N=300)

Groups		No Response	High	Average	Low	Total
Option	Science	2	96	71	0	169
		1.2%	56.8%	42.0%	.0%	100.0%
	Arts	19	35	75	2	131
		14.5%	26.9%	57.3%	1.6%	100.0%
Total		21	131	146	2	300
		7.0%	43.7%	48.7%	.6%	100.0%

The findings of this study are in agreement with a study by Abdulraheem (2011) and Musa (2004), which found out that subject specialization/subject combination influenced students' conceptions. According to Kerre (2008), initial training of primary school teachers in Kenya faced a challenge since trainees had a very weak background in science content. Hence, PTE should endeavor to improve trainees' conceptual understanding of science content. This would boost the trainees' mastery of science content and hence confidence as science teachers.

### 3.2. Conceptual understanding of science process skills

The results on trainees' conceptual understanding of SPS revealed that majority of the trainees (43.9%) in arts option rated their conceptual understanding of SPS to be averagewhile majority of the trainees (51.5%) in the science option rated their conceptual understanding to be high. Only 39.7% of the trainees in arts option indicated that their conceptual understanding of SPS was high (see Table 3).

Similar studies by Chabalengula et al. (2012), found out that pre-service elementary teachers didn't have sufficient conceptual understanding of science process skills. Studies by Lotter et al. (2007) and Luft (2001) further found out that teachers teaching different grade levels lacked sufficient understanding of science process skills. Another study by Mutisya and Rotich (2013) also found out that primary school teachers in Kenya's Narok County had poor conceptual understanding of SPS. This shows that there is no much improvement on conceptual understanding of SPS even after trainees graduate and start practicing teaching of science in Kenya's primary schools. SPS are important in the carrying out scientific investigations and teachers are expected to equip their pupils with these skills (Anderson, 2002).

**Table 3.** Conceptualization of Science Process Skill per Subject Specialization (N=300)

Groups		No Response	High	Average	Low	Total
Option	Science	4	87	73	5	169
		2.4%	51.5%	43.1%	3.1%	100%
	Arts	17	53	56	5	131
		12.7%	39.7%	43.9%	4.7%	100%
Total		21	139	129	10	300
		7.0%	46.3%	43.0%	3.3%	100%

In Kenya, Science Process Skills are taught to both trainees in the arts and science option in the first year but they either specialize in either science or arts in their second year of study. The trainees who specialize in science have more exposure to science in their second year. Thus the reason why more trainees in science option than arts option rated their conceptual understanding of SPS to be high could be explained by their longer exposure to science content. Aina (2013) observes that subject combination is very important for students seeking to pursue academic career in education. Kenya should therefore ensure that teachers who specialize in science teach science in primary schools or subject specialization in PTE is abolished all together.

### 3.3. Trainees willingness to teach science

The findings show that majority of the trainees in both science and arts options were willing to teach science during their training and after training. However, slightly more trainees (96.4%) in science option than those in arts option (77.1%) indicated they were willing to teach science during their teaching practice as teacher trainees. Those trainees who were will to teach science after training were 97.6% and 81.7% from science option and arts option respectively (see Table 4).

### 3.4. Trainees opinions on teaching of science and subject specialization

Slightly more trainees in science option (59.7%) than in arts option (41.2%) were of the opinion that subject specialization was necessary and only those teachers who specialize in science should be allowed to teach science in primary schools (see Table 5).

**Table 4.** Willingness to Teach Science Subject during and After PTE Training (N=300)

Group	Responses								
	During Training					After PTE Training			
	No Response	Yes	No	Total	No Response	Yes	No	Total	
Option	Science	0 (0.0%)	163 (96.4%)	6 (3.6%)	169 (100.0%)	0 (0.0%)	165 (97.6%)	4 (2.4%)	169 (100.0%)
	Arts	1 (0.8%)	101 (77.1%)	29 (22.1%)	131 (100.0%)	1 (0.8%)	107 (81.7%)	23 (17.6%)	131 (100.0%)
	Total	1 (0.3%)	264 (88.0%)	35 (11.7%)	300 (100.0%)	1 (0.3%)	272 (90.7%)	27 (9.0%)	300 (100.0%)

*These findings imply that trainees who specialized in science were more prepared to teach science during and after training compared to trainees who specialized in arts. Thus specialization in science subject gave the trainees confidence that they were able to manage science content as teachers. Those trainees who specialized in science had more exposure to science and hence their confidence which was demonstrated by their willingness to teach science during training and after training.*

Some trainees also held the opinion that subject specialization was not necessary since one can teach any subject so long as one is trained as a primary school teacher (16.6% and 26.0%) from science and arts options respectively. Other still had the opinion primary school teachers should teach the subject they specialized in during training though science could be taught by any trained primary school teacher (20.1% and 26.0%) of the trainees in science option and arts option respectively.

In Kenya though trainees specialize in either science option or arts option in their second year of PTE training. Primary school teachers are expected to be competent enough to handle any of the subjects taught in primary school. Hence the last two opinions were mostly informed by current practice in Kenyan school than scientific findings and hence not plausible. Subject specialization ensures that trainees have high mastery of subject knowledge. According to African Population and Health Research Centre [APHRC] (2010), lessons taught by teachers with inadequate mastery of subject knowledge tend to focus on low-level cognitive learners' tasks, which do not lead to development of critical thinking by learners.



**Table 5.** Opinions about Subject Specialization in PTE Training According to Subject Specialization (N=300)

Opinion	Subject Specialization	
	Science	Arts
Subject specialization is necessary and teachers should only teach the subjects they specialized in during PTE	101(59.7%)	54 (41.2%)
Subject specialization in PTE training is not necessary since one can teach any subjects so long as one is a trained teacher.	28 (16.6%)	34 (26.0%)
Primary school teachers should teach the subject they specialized in though science can be taught by any trained primary school teacher irrespective of the subject specialization	34 (20.1%)	34 (26.0%)
No Response	6 (3.6%)	9 (6.8%)
Total	169 (100.0)	131(100.0)

#### 4. Research implication and recommendations

These findings clearly reflect a difference in the level of primary teacher initial preparation between those trainees who specialize in science and those who specialize in arts subjects. This situation spells a dire need for Kenyans to rethink their initial training of primary school teachers. In Kenya, trainees who specialize in arts subjects may end up teaching science in primary schools since there is no specialization in teaching subjects at primary school level. In situations of severe understaffing which is so prevalent in Kenya even teachers who never specialized in science end up teaching science. It is clear that those trainees who specialize in arts feel inadequate both in science subject content and SPS. They further lack confidence in teaching of science and they may even not be willing to teach science in primary schools making their ability to teach science be questioned.

Primary education is considered to be foundational as it prepares learners to study science at higher levels. In situations where primary education is terminal, there is need to ensure learners have mastered both science subject content and SPS which they can apply to solve life problems even if their don't pursue science beyond primary education level. This is only possible if PTE trainees acquire high mastery of both the science subject matter and SPS and have the requisite pedagogies of teaching science in primary schools. The study thus recommends that training of primary school science teachers focuses on mastery of science content and SPS by all PTE trainees since they are all expected to teach science especially in situations of low understaffing. The study also recommends Kenya's Ministry of Education rethinks abolishing subject specialization in PTE and come up with a policy directing that that science in primary schools be taught by those teachers who specialized in science during their initial training. The study finally recommends in-service training for science teachers in primary schools focusing on learners' activity that enhances development of SPS and can be used by learners to construct their own scientific ideas.

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