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Teachers' Pedagogical Content Knowledge Following In-service Training in Kenya

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Abstract:

This paper examines the extent to which a participant-centered in-service professional development program impacts on teachers' attitude towards their pedagogical content knowledge (PCK) in relation to secondary school science teaching: purpose, approaches, lesson planning, limitations, and through practical work. Twenty-six (26) veteran teachers participated in in-service training workshop activities, on how to enhance secondary school science teaching, for two-weeks. Data were collected using validated pre-and post-training questionnaires. Means, standard deviations, and t-test procedures were used to analyze the data. The study found that there is positive change in teachers' attitude towards science teaching purpose ($t = -2.27, .02 < p < .05$), science teaching approaches ($t = -6.85, p < .001$), science lesson planning ($t = -10.62, p < .001$), overcoming teaching limitations in science ($t = -2.11, .02 < p < .05$), conducting practical work in science ($t = -2.71, .001 < p < .01$), and, in general, teaching science ($t = -8.91, p < .001$) after undergoing the in-service training program. The results have important implications on teachers' professional development programs, teacher educators, curriculum developers, curriculum implementation, and instructional supervision of science teachers.

Keywords: in-service teacher education, Teacher attitudes, Kenya, Pedagogical content knowledge

1. Introduction

Scientific concepts may become concrete in students' minds through experimentation. Research studies indicate that student experiments do provide learners with opportunities to perceive and recognize the environment, observe and build cause-effect relationships, and learn science through hands-on activities (Lee, Lai, Yu & Lin, 2012). Secondary school teachers who plan for student experiments may assist learners to have meaningful learning and improve on their self-confidence and motivation; learn about themselves; develop problem-solving, psychomotor, analytical thinking and mental skills; and view of the relationship between science and everyday life (Russell & Weaver, 2011). Class experiments not only help students to learn more meaningfully and develop science process skills but also assist them to be productive and creative individuals capable of applying gained knowledge in real life situations (Saat, 2010).

Laboratory practices are useful for students' cognitive and affective development (Saad & Boujaoude, 2012). Veteran teachers are aware that laboratories are places where students learn science concepts, principles, and laws through experimentation (Fadzil & Saat, 2014). Teachers know that the process of experimenting involve students in observations, measurements, classifications, recording data, formulating hypotheses, designing experiments and controlling variables. In addition, veteran teachers are aware that students' laboratory practices not only foster academic achievement but also contribute to meaningful learning through interpretation of knowledge (Spronken-Smith, Walker, Batchelor, O'Steen, & Angelo, 2012). This argument concurs with Tafa (2012) who observed that successful laboratory practices influence students' self-esteem, social behavior and relationship with others. Experienced teachers may have adequate pedagogical knowledge that science students benefit from their laboratory and classroom practices.

Other studies indicate that laboratories not only provide a platform for learning through hands-on activities and gathering scientific knowledge in different ways but also contribute to the development of students' psychomotor skills (Pekbay & Kaptan, 2014). This implies that veteran teachers ought to be aware that laboratory activities do equip students with cognitive, affective, and psychomotor skills such as designing experiments, understanding how theories emerge from experiments, analyzing data, writing scientific reports, discussion, making presentations, induction and deduction techniques, problem solving, team work, time management, motivation and self-confidence. This argument agrees with that of espoused by Del Carlo and Bodner (2009) who noted that students view laboratory experiences as opportunities for problem-solving in relation to the cognitive domain.

To keep pace with rapid developments in technology and science, teachers ought to equip their learners with knowledge and skills required in the said developments. This makes it vitally important to increase the quality of students' laboratory practices (Saçıcı,

2013). To manage the process of teaching and learning in a healthy way, a teacher needs to be well-qualified, since they are the guides and regulators of the process of education. The educational process is composed of student-teacher relationship. This relationship necessitates increasing teachers' pedagogical content knowledge to enhance students' achievement in science. Increase of teachers' pedagogical content knowledge is likely to depend upon the acquisition of related competences through pre-service and in-service training programs (Ekizler, 2013).

It is through instructional technology and material development courses in pre- and in-service teacher education that teachers acquire needed competences in their pedagogical content knowledge (Senler, 2011). At micro level, the design of teaching-learning processes lies in the hands of a teacher. Thus, the teacher should be knowledgeable about the design of their teaching materials. Taking advantage of this information, teachers should prepare effective learning materials and use them (Beehjo, 2013). To develop effective learning materials, instructional technology is an important factor due to their interrelationship (Kaya, 2006). Instructional technology uses a combination of all possible resources to achieve goals set by a teacher; while design and implementation are the necessary materials to systemize the teaching process. Teachers have a task of designing teaching processes to realize their goals through instructional technology and making educational process productive.

Studies related to instructional technologies and material development show that practicing veteran teachers seem to be more efficient than pre-service teachers in using instructional technologies (Beehjo, 2013). In addition, teachers appear to have positive attitudes towards instructional technologies and material development but seem hardly involved in use of instructional technologies and material development. Perhaps, this is due to inadequate provision of materials in schools while some teachers might not be having sufficient knowledge in the said areas. However, other studies indicate that pre-service science and mathematics teachers appear to have a high level of self-efficacy in computers with a positive relationship between their computer self-efficacy and attitudes towards computers (Ekizler, 2013). This relates well with Saçıcı, (2013) who noted that use of computers and internet to achieve professional goals has a positive effect on teacher self-efficacies. Teachers' self-efficacy may positively influence their attitudes towards use of computers and access to internet during teaching-learning processes in science. Thus, teachers' training based on use of computers and internet is likely to have a positive impact on their pedagogical content knowledge in science.

Pre-service teachers are prepared for their roles in schools following approved teacher education curricula in Kenya. School teachers are required to frequently undergo in-service training depending on the need at hand. The in-service courses are organized and directed by the Ministry of Education, Science and Technology Quality Assurance and Educational Standards officials in collaboration with the Teachers Service Commission. Veteran science teachers enhance their pedagogical content knowledge through continued teaching and professional development programs. Against this background, there was need to find out teachers' opinion about their in-service training aimed at improving on their pedagogical content knowledge leading to enhanced teaching and learning about science in schools.

2. Method

The study focused on 26 veteran teachers of science purposively selected from six regions in Kenya based on teaching experience, annual appraisals, and school category. The teachers undertook a ten-day in-service pedagogy course on how to enhance teaching of science in schools. The training curriculum covered innovative teaching approaches, planning, and practical work in science. The teachers experienced hands-on, hearts-on and minds-on activities through discussions, reflections, demonstrations, experimenting on small-scale experiments, and development of instructional materials. In so doing, teachers had a feel of the very teaching methodologies and activities required for effective teaching of science subjects in schools.

Impact of the in-service training on teachers' views about various issues in teaching science subjects was assessed using validated pre- and post-training questionnaires (internal consistency reliability, Cronbach's alpha, of 0.81). In-service teachers responded to items in pre- and post-training questionnaire developed based on areas covered during the in-service training. The questionnaire had six sections with a total of 66 items: learning objectives (8 items); teaching approaches (15 items); planning (15 items); teaching limitations (18 items); and practical work in science (10 items). In each case, teachers responded to items in the questionnaire by indicating the extent to which they agreed or disagreed with the item statement. The responses were coded on a scale of 0 to 4 where: 0 is a code for "Strongly Disagree"; 1 for "Disagree"; 2 for "Not Sure"; 3 for "Agree"; and 4 for "Strongly Agree".

Data obtained were analyzed category-by-category by computing mean response code for each questionnaire item, pre-training and post-training mean response codes and standard deviations of the mean response codes in each category; and t-test for comparison of means at .05 level of significance. The effect size based on Cohen's guidelines was also computed. Questionnaire items were constructed in such a way that if a computed mean response code for an item fell between 0 and 1.00, then a strong negative attitude is inferred; between 1.00 and 2.00, a negative is inferred; on 2.00, a neutral attitude is inferred; between 2.00 and 3.00, a positive attitude is inferred, and between 3.00 and 4.00, a strong positive attitude is inferred.

3. Results

In-service teachers' responses to items in the section of learning objectives in science were analyzed using means, standard deviations and t-test procedures. Result for learning objectives is shown in Table 1.

In-service Group	n	μ	σ	SE	t	p	ES (d)	95%CI
Pre- training Evaluation	26	2.50	1.13					
Post- training Evaluation	25	3.15	.89					
Comparison of Means				.286	-2.27	.02<p<.05	-.638	(-1.228, -.072)

$$t^*_{49, .05} = 2.021$$

Table 1: Teachers' View about Science Learning Objectives

The result is statistically significant ($t = -2.27$, $.02 < p < .05$) and based on Cohen's guidelines on effect size, the results are practically significant or important ($d = -.638$). This shows that there is sufficient evidence to support the statement that there is a positive change in teachers' attitude towards science learning objectives after undergoing an in-service training program.

An analysis of teachers' responses to items on teaching approaches in science was also done using means, standard deviations and t-test procedures. Results are presented in Table 2.

In-service Group	n	μ	σ	SE	t	p	ES (d)	95%CI
Pre- training Evaluation	26	2.88	.37					
Post- training Evaluation	25	3.49	.25					
Comparison of Means				.089	-6.85	<.001	-1.92	(-.80, -.43)

$$t^*_{49, .05} = 2.021$$

Table 2: Teachers' Opinion about Teaching Approaches in Science

The result is statistically significant ($t = -6.85$, $p < .001$) and based on Cohen's guidelines on effect size, the results are practically significant ($d = -1.92$). This provides sufficient evidence to support the statement that teachers positively change their attitudes towards use of various science teaching approaches after undergoing in-service training.

The study also focused on whether there is a positive change in teachers' attitude towards planning in science subjects in secondary schools. Result for the analyzed data on this category is presented in Table 3.

In-service Group	n	μ	σ	SE	t	p	ES (d)	95%CI
Pre- training Evaluation	26	3.07	.31					
Post- training Evaluation	25	3.76	.10					
Comparison Of Means				.065	-10.62	<.001	-2.97	(-.82, -.56)

$$t^*_{49, .05} = 2.021$$

Table 3: Teachers' Lesson Planning in Science

The result is statistically significant ($t = -10.62$, $p < .001$) and based on Cohen's guidelines on effect size, the results are practically important ($d = -2.97$). This gives sufficient evidence to support the statement that teachers positively change their attitudes towards lesson planning for secondary school science subjects after undertaking an in-service course on effective lesson planning.

In the study, in-service teachers were asked to respond to items limitations teachers face when teaching science subjects in secondary schools. Teachers' responses were analyzed and the result is shown in Table 4.

In-service Group	n	μ	σ	SE	t	p	ES (d)	95%CI
Pre- training Evaluation	26	2.70	.89					
Post- training Evaluation	25	3.26	1.01					
Comparison of Means				.266	-2.11	.02<p<.05	-.589	(-1.098, -.022)

$$t_{49, .05}^* = 2.021$$

Table 4: Teachers' Effectiveness in Teaching Science

The result is statistically significant ($t = -2.11$, $.02 < p < .05$) and based on Cohen's guidelines on effect size, the results are practically significant ($d = -.589$). This points out sufficient evidence to support the statement that there is a positive change in teachers' attitude towards their ability to overcome teacher limitations in teaching secondary school science subjects after undergoing training program on how to overcome teaching challenges in schools.

In-service teachers responded to items on how to conduct various types of experiments/practical work in secondary school science. Result for the analyzed data is provided in Table 5.

In-service Group	n	μ	σ	SE	t	p	ES (d)	95%CI
Pre- training Evaluation	26	2.95	.26					
Post- training Evaluation	25	3.30	.60					
Comparison of Means				.129	-2.71	.001<p<.01	-.762	(-.61, -.09)

$$t_{49, .05}^* = 2.021$$

Table 5: Teacher Perceptions about Practical Work in Science

The result is statistically significant ($t = -2.71$, $.001 < p < .01$) and based on Cohen's guidelines on effect size, the results are practically noteworthy ($d = -.762$). This delivers sufficient evidence to support the statement that teachers positively change their attitude towards conducting various types of experiments/practical work when they undertake participatory-based in-service training workshops on how to effectively conduct practical work sessions in science.

The study also focused on teachers' attitude towards teaching secondary school science subjects before and after the in-service sessions. Computed mean and standard deviation values were subjected to t-test procedures to find out if there is statistical difference between the means for pre-and post-training evaluations. The result is summarized in Table 6.

In-service Group	n	μ	σ	SE	t	p	ES (d)	95%CI
Pre-training Evaluation	26	2.82	.22					
Post-training Evaluation	25	3.39	.24					
Comparison of Means				.064	-8.91	<.001	-2.48	(-.70, -.44)

$$t_{49, .05}^* = 2.021$$

Table 6: Teachers' Opinion about Teaching Secondary School Science

The result is statistically significant ($t = -8.91$, $p < .001$) and based on Cohen's guidelines on effect size, the result is practically meaningful ($d = -2.48$). This shows that there is sufficient evidence to support the statement that there is positive change in teachers' attitude towards science teaching in secondary schools in Kenya following in-service training.

4. Discussion

From all the computed t-values, $p < .05$, and the standardized mean differences gave a large effect size based on Cohen's guidelines in which an effect size of .8 is considered to be large for a result to be practically significant. It can be argued that the pre-in-service training evaluation results indicate that teachers' attitude is positive towards issues on all the five categories: teaching/learning purpose/objectives, using various teaching strategies/approaches in science, lesson-planning, ability to overcome teacher limitations in teaching, and conducting various types of practical work in science. This appears to have improved and became more positive during the in-service training sessions. This can be attributed to areas addressed during the workshop activities such as teaching strategies/approaches, lesson planning, simple class experiments, and rationale for experimental work in secondary schools, among others. These topic areas along with discussion, hands-on, demonstration, and peer-teaching sessions are likely to have exposed in-service teachers to salient features of teaching/learning in the classroom (Inyega, 2011).

On the other hand, in-service teachers' attitude towards work planning positively changed as reflected by pre- and post-in-service training evaluation results ($t = -10.62$, $p < .001$, $d = -2.97$). This might have been due to the fact that aspects of lesson planning were addressed and teacher-friendly lesson plan models developed by the teachers themselves. The model appeared to be easy to prepare and use by teachers. However, there is need for teachers to prepare lesson plan samples in specific topic areas of high school science subjects and try them out in schools to determine their suitability and workability in actual classroom situation. In so doing, teachers are likely to enhance their teaching through effective lesson planning and implementation.

Many rural schools in Kenya are likely to have inadequate provision of conventional apparatus and chemicals for practical sessions in science. In-service teachers had hands-on activities on how to improvise locally available materials during practical sessions in school science. Peer-teaching sessions might have also helped teachers to encounter and deal with teaching challenges in a practical way (Inyega, 2011). On the other hand, there is need to prepare a set of relevant in-service activities on how to cope with other issues such as school duties other than teaching; large student/teacher ratio; low morale among fellow teachers; low morale among students; individual differences and background of students. Further research may inquire into these issues.

5. Conclusion

It is evident from the analyzed data results that participatory-based in-service professional development programs positively change teachers' attitude towards various aspects of teaching secondary school science. This is likely to lead to effective teaching of secondary school science subjects and consequently enhance student achievement in science due to teachers advanced pedagogical content knowledge through in-service training.

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