EFFECT OF IN-SERVICE TRAINING ON SCIENCE TEACHERS' SELF-EFFICACY BELIEFS AND CONTENT KNOWLEDGE COMPETENCIES IN BASIC ELECTRONICS IN THE GHANAIAN JUNIOR HIGH SCHOOL CONTEXT

Victor Antwi
Department of Physics Education
UEW, **GHANA**

Ishmael Kwesi Anderson
Department of Physics Education
UEW, **GHANA**

Oscar Kubirizegah Abagali
Department of Science Education
UEW, **GHANA**

ABSTRACT

Pupils, particularly girls, who enter secondary schools with high favourable attitude towards science and interest in science, soon see these qualities eroded by their experience of school science. Teachers are the fulcrums of pupils' school science experiences in Junior High Schools (JHS) basic electronics. This study therefore, was to determine JHS science teachers' self-efficacy beliefs and content knowledge competencies in basic electronics and whether attending an in-service programme could change these characteristics. The study involved 46 participants; JHS science teachers in Kassena Nankana Municipal, in the Upper East Region of Ghana. Science teachers were assessed using pre-workshop questionnaires and again, with post-workshop questionnaires after an in-service workshop on JHS basic electronics. The data collected was subjected to qualitative analysis and an inferential t-test analysis for paired (dependent) samples. The findings of the study showed that science teachers had initial moderate self-efficacy beliefs but developed high self-efficacy beliefs after the in-service training. Also, the study showed that JHS science teachers initial content knowledge competencies (MS=32.8%, SD=22.86) needed improvement as compared to their excellent content knowledge competencies (MS=89.9%, SD=8.49) in the post-workshop state. The differences in content knowledge competencies was significant ($t(45) = 16.477$, $p = 0.000$). These findings therefore, suggest that regular and continual in-service training targeting specific sensitive challenging content areas in basic electronics (science) should lead to teachers' developing the coping abilities to teach the content area and meet the specific task needs of pupils.

Keywords: In-service training, self-efficacy beliefs, Content Knowledge Competencies, Electronics, JHS, Ghana.

INTRODUCTION

Electronics engineering, information and communications technology (ICT) and electronic systems appear to have drastically changed the mode of storage, retrieval, transmission and reception of information [1]. In Ghana, basic electronics was introduced into the basic school's science curricular during the Ghana Education reforms in 2007 [2]. In 2012 the contents were reviewed, so as to move along with the world' trends in modern technological development [3]. Interactions with some of the science teachers and pupils had revealed that many Junior High Schools (JHS) science teachers in Ghana, especially in the Upper East Region, have not developed the full capacity in terms of content knowledge competency to teach basic electronics at the JHS, though teachers who strengthen their knowledge base are better prepared to teach [4], [5]. The science teachers who might seem to be teaching the basic electronics might do so using knowledge gained from their pre-tertiary education and other sources of self-motivational learning. Other JHS science teachers teach the subject using self-motivational learning characterized by their self-efficacy beliefs; the I too, can do it philosophy [1]. Self-efficacy beliefs could probably play some roles in teachers' teaching efforts as some JHS science teachers in KNM did not read General Science or its related programmes at the SHS/SSS, Colleges of Education or in the Universities. Nevertheless, it could be assumed that all these science teachers might have organised relevant and meaningful basic electronics lessons with their pupils. Most of the science teachers teach the practical aspect of the basic electronics without any teaching and learning materials, rendering the subject not to be attractive to pupils. Pupils therefore do not appreciate the nature of electronic devices, understand how to maintain and reduce risks involved in using electronic devices and subsequently do not consider it as a career in future, perhaps due to the teachers' approach in teaching of the theory and practical aspects of the basic electronics. However, looking at the high rate at which teachers and pupils are seemed to be exposed to modern electronics and computerized technologies, one would have expected to see that teaching and learning of basic electronics should be easier to both parties, but unfortunately that is not the case. In this study, quasi-experimental approach will be considered through the use of in-service training of JHS science teachers in the Upper East Region of Ghana to determine its impact on their content knowledge competency in basic electronics. Results of the pre- and post-workshop questionnaires will be converted into proportion mean scores and compared to determine whether there would be an improvement in the initial content knowledge competency in the JHS science teachers or not.

REVIEW OF RELATED LITERATURE

Teachers' Self-Efficacy Beliefs

Teacher's self-efficacy belief is the "belief in one's capabilities to organize and execute the courses of action required for managing prospective situations" [7]. On this basis Tschannen-Moran, Hoy and Hoy [8] said teacher self-efficacy can be the teacher's beliefs in his/her capability or competency to successfully organize and execute course of actions required to achieve specific teaching task in a particular context. It expresses competences towards specific areas of knowledge or skill; that is self-efficacy belief is task/ability specific. Accordingly, Bandura [9] states that "People with high assurance in their capabilities approach difficult tasks as challenges to be mastered rather than as threats to be avoided, (p2)". Thus, teachers with high self-efficacy beliefs are likely to explore the environment, seek peer support, and create the right emotional settings that enable them to observe and rehearse the action(s) performed by models in order to continue to overcome their own challenges [6].

Also Elliott, Kratochwill, Cook and Travers [10] shows that when teachers believe they can succeed in teaching any subject or lesson, they are more likely to do so. Therefore, teachers' perceived self-efficacy beliefs play major roles in decision making, especially in teaching; decisions on selection of activities, classroom management, and effective lesson presentations, especially in the current dispensation of varying educational technologies [6].

Gür, Çakiroğlu, and Çapa- Aydin [11] emphasised that teachers with high self-efficacy beliefs are more likely to experiment and test new methods, implement innovative curriculum content, practise new teaching ideas; particularly concepts that are difficult to teach and involve risks. They also found out that cyclically teachers with low levels of self-efficacy (beliefs) exert low levels of effort and achieve low performances target while those who have low performances as a result of exerting low efforts drift into lower levels of self-efficacy beliefs.

Teachers' Self-efficacy beliefs and Content knowledge competency acquisition

According to Bandura [6] employees (which includes teachers) of high perceived efficacy have a preference for training that "enables them to restructure their roles innovatively by improving the customary practices and adding new elements and functions to them" and that "Self-efficacious

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employees take greater initiative in their occupational self-development and generate ideas that help to improve work processes" (p.181).

Also Bandura [7] emphasises that teachers with high sense of self-efficacy beliefs set "challenging goals and maintain strong commitment" to achieve them. "They maintain a task-diagnostic focus that guides effective performance". They put in much effort to avoid failure, but if failure occurs, they tend to attribute the "failure to insufficient effort or deficient knowledge and skills that are acquirable" (p.144). Again Bandura [6] noted that perceived self-efficacy beliefs do not let people "only set the slate of options for consideration, but also regulates their implementation", by mobilizing effort and resources to accomplish "the decided course of action successfully and stick to it in the face of difficulties". He stressed that when people are "faced with obstacles, setbacks and failures, those who doubt their capabilities slacken their efforts, give up prematurely, or settle for poorer solutions". However, "those who have a strong belief in their capabilities redouble their effort to master the challenges" (p.180).

There is therefore the likelihood that teachers may have high self-efficacy beliefs towards tasks but lack resources (content knowledge and skills) to execute their beliefs. Thus, to achieve these self-efficacy beliefs expectancies teachers will have to acquire the requisite knowledge and skills. Generally, it is noted that people do not easily perform well on any given task unless they have the needed content knowledge competencies regarding that specific task. This is because competency in content knowledge is task specific just as self-efficacy belief is task specific [9]. Content knowledge competency relates to a person's capabilities and abilities towards achieving sets of goals in specific situations using a set of cognitive processes relating to a subject matter content. Thus, Bourne and Russo [12] indicated that a person's competency could promote person's self-efficacy beliefs and one's self-efficacy beliefs essential and potentially exposes one's competency traits. In a similar relation Drits [13] indicated that teachers with high content knowledge and pedagogical content knowledge have higher confidence in science teaching self-efficacy and were ready to teach using reform-based inquiry approaches.

IN-SET for content knowledge competency development

In-service training is any form of staff development engagement that tends to promote the quantitative growth and qualitative development of knowledge and capacity of the participants. Jahangir, Saheen and Kazmi [14] describes IN-SET as a catalyst that provokes significant changes in teachers knowledge (content matter), redefines their roles, broadens their vision and enhances their pedagogical attributes as teachers.

Satterfield [15] identified that IN-SET can take the forms of self-directed learning, observation and assessment, participation in institutionalised level improvement process and participation in small-peer group inquiry. Therefore, an IN-SET programme is organised to give the teachers the ability to acquire adequate content matter knowledge and pedagogies to effect classroom performance.
Research shows that the implementation of any innovative science curricular objectives depends on strong science-based teachers who have the capacity to interpret the curricular objectives, understand and use the materials effectively [16]. Again, Black [17] said good curricula materials would fail to produce good results because they failed to convince the uninformed teachers to take them seriously. Therefore, national education policies (on JHS basic electronics) should consider given teachers IN-SET to gain content knowledge competencies to use these science curricula materials/resources for the benefit of pupils. Jahangir, Saheen, and Kazmi [14] indicates that an effective teacher has the ability to master the subject content and exhibit professionalism in

pedagogical training. Therefore, an IN-SET programme for teachers should have the tendency to increase these good qualities.

Teachers' content knowledge competency

According to Naumescu [18] competency is not about mastery of knowledge, methods and the ability to use them; it involves the ability to combine different basis of the knowledge and skills to meet specific tasks. It is a characteristic acquired through self-experience, self -belief and educational training in a given field of study and in specific areas of situational challenges [6].

According to Alorvor and el Sadat [19] the criteria for appraising basic schools teachers' competencies in Ghana are communication skills, lesson presentation, personality traits, knowledge of subject matter, evaluation of learners' ability, teachers' punctuality and attendance, the teachers' relationships and participation in coordinating activities [6].

Many reforms in the field of science teacher education suggest that teacher need "threefold structures" of knowledge such as subject content knowledge, Pedagogical Knowledge and Pedagogical Content Knowledge [6], [20]. Subject content knowledge (CK) comprises the basic theories, principles, facts, ideas, skills and concepts that make up the body of knowledge of the subject. Subject content knowledge competency (CKC) is considered as the ability of a teacher to organise coherently these entities of concepts in the body of knowledge into meaningful and usable concepts that meet modern research findings [10].

Many students have good preference for some subjects because their teachers show good command of the content during lesson delivery. Science teachers with good competency in the science content area are likely to transfer the same enthusiasm to the pupils [21]. Studies have shown that science teachers who feel uncomfortable with subject content knowledge tends to avoid teaching some details of the content or teach it hurriedly without attending to the emotions and attitudes of their students [18].

Electronics and electronic system circuits

Electronics is a branch in physics and engineering that involves the flow of electric charges through useful devices. Electronic components are used in broad products that include radios, television sets, computers, medical instruments, entertainment gadgets and many more. People rely much on these electronic products for communication, information processing, medicine and research, automation, industrial use and for air, land, sea and space travel for their daily survival such that they classify this age as the electronic age [22]. Scientists and engineers continue to search for ways to make electronic circuits smaller, faster and more complex. Other likely areas of application of electronics systems are photonics, robotics, mechatronics and most automation engineering as well as the basis for the hardware and software used in the information technologies [23]. Therefore, to understand the concepts of advanced electronics it depends on the knowledge of basic electronics, simple discrete components and their variations – cell, resistor, capacitor, inductor, diode and transistor [1].

Purpose of the study

The purpose of this research was to investigate the impact of JHS science teachers' self-efficacy beliefs and content knowledge competency in basic electronics before and after an in-service and educational training intervention.

Research questions

The study was focused on these research questions: "
1. What are the differences in JHS science teachers' self- efficacy beliefs towards teaching basic electronics before and after an IN-SET workshop?
2. What are the differences in JHS science teachers' level of content knowledge (competencies) in basic electronics before and after an IN-SET workshop?

Research Hypotheses

H_1: There is no significant difference in the JHS science teachers' self-efficacy beliefs towards basic electronics before and after an IN-SET workshop.

H_2: There is no significant improvement in the JHS science teachers' content knowledge (competencies) in basic electronics after an IN-SET workshop.

METHODOLOGY

The Research Design

Quasi-experimental approach was the design for this study, which used quantitative and qualitative methods to collect and analyse the data. The method combined these approaches to maintain convergence and dissonance found in both approaches [24].

Forty six (46) JHS science teachers (include all female science teachers) were purposively sampled from forty-one (41) JHS in the KNM in the upper east region of Ghana. The research data collection was in two phases. The first phase was the collection of data from a pre-workshop questionnaire administered to the JHS science teachers at their respective schools and pre-test questions designed in a workshop manual. The second phase of data collection was from a post-workshop questionnaire administered to the teachers and post-test questions similar to the pre-test questions given to the teachers after the IN-SET workshop organised for them at Navrongo Senior High School. The pre- and post-workshop questionnaires and the pre-test and post-test were the major instruments for collecting the respective data before and after the IN-SET workshop for this study**.** The data is then subjected to statistical analysis to respond to the research question and hypothesis from which conclusions were drawn.

Workshop Manual

An IN-SET workshop manual was used as an intervention material to assist the teachers to acquire content knowledge in basic electronics. The workshop manual had hands-on activities patterned to promote exploration of basic electronics components' as required by the JHS integrated science syllabus [3]. It therefore, served as a guide to teachers to improve upon their content knowledge competencies through practical activities that orient them to do, see, write and explain simple observations on basic electronics circuits [5]. Teachers were asked to construct the circuits in the workshop manual, observe the output of the light emitting diode (LED), and record their observations in the workshop manual. From circuit observations, science teachers responded to some question items of each exercise.

Each teacher used a workshop manual with basic electronics kit which includes 2 capacitors (100ɥF-16V, 1000ɥF-16V), 5 fixed resistors (3.3kΩ, 10kΩ, 100kΩ, 470Ω, 560Ω), and one metre (1m) long of single core insulated copper wires (SWG 32 diameter width) to make inductors. The other components in the kit are general purpose diodes (1N5392), 4 LED (white, red, yellow, and multiple colour flashers), 1 transistor (NPN, serial code BC548) and a breadboard for circuits' construction.

Data Analysis

Highest educational qualification attained by JHS science teachers

JHS science teachers have varied educational qualifications from WASSCE to Degree, with which they use to teach. Among the 46 participating JHS science teachers 4.4% (2) were holders of Teacher Certificate 'A', 50% representing twenty three (23) teachers had Untrained Teachers Diploma (UTDBE) / Diploma in Basic Education certificates and 4.4% (2) had Higher National Diploma certificate. Also 39.1% comprising eighteen (18) of the teachers hold Post-Diploma/First Degree certificates while one teacher (2.1%) is a West African Senior School Certificate Examination (WASSCE) holder.

Teachers' experience of basic electronics at workshops and other sources of knowledge in basic electronics

Teachers' prior and current experience in learning basic electronics in workshops and other resourceful areas was determined and the results pointed out that 78.2% representing thirty-six (36) science teachers had not learnt any content knowledge on basic electronics in previous workshops, 9.6% comprising nine (9) teachers had fairly learnt some content knowledge in basic electronics while 2.2% representing one (1) teacher who had learnt good content knowledge on basic electronics in previous workshop attended. The results could suggest that about 98% of the teachers did not acquire adequate content knowledge on basic electronics in previous in-service trainings. Therefore, this workshop was a good intervention to assist them to teach basic electronics in JHS.
Furthermore, the results indicated that 56.5% representing twenty-six (26) science teachers learnt some content knowledge of basic electronics in SHS and College of Education while 4.4% (2) acquired the knowledge at the University. The remaining 39.1% (18) of science teachers did not acquire content knowledge on basic electronics at formal institutions.

Now after the in-service workshop for this research study, science teachers were asked to indicate their levels of satisfaction with the workshop in relation to learning basic electronics. It was found out that 41% representing nineteen (19) science teachers were of the view that they benefited greatly from the workshop, 52% (24) had a good level of satisfaction while 7% (3) of teachers were fairly satisfied with the support the IN-SET workshop offered. None of the participants were dissatisfied with the IN-SET workshop intervention.

The results could suggest that majority of the teachers did not acquire adequate content knowledge on basic electronics in previous in-service trainings. Therefore, this workshop was a good intervention to assist them to teach basic electronics in JHS. Now after the in-service workshop for this study, none of the participants was dissatisfied with the IN-SET workshop intervention.

Research question 1

What are the differences in JHS Science Teachers' Self-Efficacy Beliefs towards Basic Electronics before and after an IN-SET workshop?

Both pre-workshop and post-workshop questionnaires had 14 items which were meant to measure the JHS science teachers' self-efficacy beliefs towards basic electronics. The items numbered 1, 11,

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12, 13 and 14 were reversed coded because they were negatively worded statements while the other nine (9) items were positive statements. As a five-option Likert-type scale the responses for the positively worded items were rated and scored as follows: "Strongly Disagree – 1; Disagree – 2; Uncertain – 3; Agree – 4; Strongly Agree – 5". The reversed coded items were rated and scored as: Strongly Disagree – 5; Disagree – 4; Uncertain – 3; Agree – 2; Strongly Agree – 1. As five-points Likert-type scale coding, some researchers assign a score of 3.0 to reflect a neutral response and scores of 0.56 to 1.0 standard deviations above and below this mark to represent high and low levels of efficacy respectively [25], [26].

Therefore, the data of the study are analysed such that any decimal mean score is converted to the nearest whole and then rated. Thus, a mean score of 3 is considered as moderate level of self-efficacy beliefs and a score of 0.56 standard deviations below and above a score of 3 are interpreted as low self-efficacy beliefs and high self-efficacy beliefs respectively. Table 1 presents data of JHS science teachers' perceived SEB on the difficulty of JHS basic electronics, perceived time devotion towards basic electronics and perceived competency to Handle JHS Classroom activities.

Table 1: JHS Science Teachers SEB on Perceived Difficulty of JHS Basic Electronics, perceived time devotion towards basic electronics and perceived competency to Handle JHS Classroom activities

Self-efficacy beliefs item statements on Perceived Difficulty of JHS Basic Electronics					
Item No.	**Pre-Workshop MS (SD)**	**Post-Workshop MS (SD)**	**Mean diff**	**t-test value**	**Sig.**
1(9)** (RC)*	2.72 (1.46)	3.78 (0.76)	-1.065	-4.69	0.000
2(3)	4.48 (0.91)	4.33 (0.60)	0.152	0.98	0.332
3(1)	4.04 (1.15)	4.15 (0.52)	-0.109	-0.64	0.528
5(6)	3.39 (1.29)	4.02 (0.54)	-0.913	-3.93	0.000
10(12)	3.02 (1.33)	3.63 (0.80)	-0.609	-2.81	0.007
11(13) (RC)*.	3.93 (1.42)	4.02 (0.54)	-0.087	-0.44	0.660
12(14) (RC)*.	3.61 (1.27)	3.63 (0.77)	-0.022	-0.10	0.919
13(4) (RC)*.	3.07 (1.67)	4.30 (0.59)	-1.239	-5.27	0.000
14(2) (RC)*.	1.50 (0.89)	4.26 (0.65)	-2.761	-17.70	0.000
Overall mean score of 1(9), 2(3), 3(1), 5(6), 10(12), 11(13), 12(14), 13(4) and 14(2)	3.30	4.05	0.75	7.70	0.00
Self-efficacy beliefs item statement on perceived time devotion towards basic electronics					
Item No.	**Pre-Workshop MS (SD)**	**Post-Workshop MS (SD)**	**Mean Diff**	**t-test value**	**Sig.**

*4 (5)	4.20 (1.167)	4.30 (0.695)	-0.174	0.88	0.38

Self-efficacy beliefs item statements on perceived competency to Handle JHS Classroom activities

Item No.	Pre-Workshop MS (SD)	Post-Workshop MS (SD)	Mean Diff	t-test value	Sig.
*6(7)	3.1 (1.36)	3.9 (0.78)	-0.804	-3.75	0.001
*7(8)	3.4 (1.24)	3.9 (0.57)	-0.522	-2.93	0.005
*8(10)	3.6 (1.24)	4.0 (0.58)	-0.457	-2.42	0.019
*9(11)	3.7 (1.06)	4.1 (0.65)	-0.391	-2.49	0.016
Overall mean score for 6(7), 7(8), 8(10) and 9(11)	3.4 (1.06)	4.0 (0.50)	0.60	3.56	0.000

**Pre-workshop (Post-workshop) items; (RC)*- Reversed Coded item responses; SD – Standard Deviation in parenthesis; MS – Mean Score.

Analysis of Table 1 indicates that before JHS science teachers attended the IN-SET workshop they had moderate self-efficacy beliefs (MS = 2.72 ≈ 3.0) that practical activities in basic electronics were difficult to teach in JHS. However, after attending the IN-SET workshop JHS science teachers attained high self-efficacy beliefs (MS = 3.78) that practical activities of basic electronics were not difficult to teach in JHS. Nonetheless, JHS science teachers had high self-efficacy beliefs, both before (MS = 4.46) and after (MS = 4.33) attending the IN-SET workshop, that they could teach JHS basic electronics when they seriously study on its content. Again JHS science teachers had expressed high self-efficacy beliefs, both before (MS = 4.04) and after (MS = 4.15) the IN-SET workshop, that they had self-motivation that they could teach the contents of basic electronics in JHS. Also, these JHS science teachers had indicated high self-efficacy beliefs, both before (MS = 3.9) and after (MS = 4.02) the IN-SET workshop, that they had adequate content knowledge to teach basic electronics in JHS.

However, before the IN-SET workshop JHS science teachers expressed moderate self-efficacy beliefs (MS = 3.02) that basic electronics in JHS science syllabus [3] was easy to teach. Nonetheless, after the workshop they had shown high self-efficacy beliefs (MS = 3.63) that basic electronics was easy to teach in JHS. Interestingly, the levels of self-efficacy beliefs of JHS science teachers before (MS = 3.93) and after (MS = 4.02) the IN-SET workshop were high against (reversed coded interpretation) the statement that they could not teach basic electronics in any of their science lessons in JHS. Again these teachers had high SEB, both before (MS = 3.61), and after (MS = 3.63) the IN-SET workshop against the statement that they could teach only some portions of basic electronics in their science lessons in JHS.

Before JHS science teachers attended the IN-SET workshop they had moderate self-efficacy (MS = 3.07) that JHS basic electronics should not be taught by JHS science teachers, but their self-efficacy beliefs were raised (MS = 4.30) against this premises, after the IN-SET workshop. Also, before JHS

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science teachers attended the IN-SET workshop they had expressed low self-efficacy beliefs (MS = 1.50) indicating that they needed more content knowledge in order to identify discrete basic electronics components used in JHS. Nonetheless, they developed high self-efficacy beliefs (MS = 4.26) after the IN-SET workshop indicating that they believed that they had sufficient content knowledge to identify discrete basic electronics' components used in JHS.

In summary, overall self-efficacy beliefs of JHS science teachers on the perceived difficulty of JHS basic electronics before attending the IN-SET workshop as moderate (MS = 3.3). However, JHS science teachers' uncertainty in self-efficacy beliefs on the perceived difficulty of basic electronics content knowledge diminished after the IN-SET workshop resulting in the development of an overall post-workshop high self-efficacy beliefs (MS = 4.05). In both the overall item responses and that of all the individual item responses, there are significant differences between JHS science teachers' self-efficacy beliefs after and before the IN-SET.

Furthermore, Table 1 indicates that JHS science teachers had high self-efficacy beliefs, both before (MS = 4.2) and after (MS = 4.30) the IN-SET workshop that they could devote adequate time to study basic electronics before attending their science lessons in JHS. Also Table 1 shows that before JHS science teachers attended the IN-SET workshop, they had shown moderate self-efficacy beliefs (MS = 3.1) as against the high self-efficacy beliefs (MS = 3.9) expressed after the workshop, that, they could carry out hands-on activities on JHS basic electronics with their pupils. As to whether they were confident that they could solve JHS pupils' difficulties in learning basic electronics, JHS science teachers had shown that they possessed moderate self-efficacy beliefs (MS = 3.4) as against high self-efficacy beliefs (MS =3.9) before and after the IN-SET workshop respectively.

Nonetheless, JHS science teachers had shown that they had possessed high self-efficacy beliefs both before (MS = 3.6) and after (MS = 4.02) the workshop on the premises that they could confidently draw basic electronics circuits as required by the current JHS science syllabus (MOE, 2012). Also, science teachers had shown high self-efficacy beliefs, both before (MS = 3.7) and after (MS = 4.1) the IN-SET workshop that they could confidently answer evaluation questions on JHS basic electronics. In general, on the premises of JHS science teachers' perceived competencies to confidently handle classroom activities with pupils, JHS science teachers' had expressed moderate self-efficacy beliefs (MS = 3.4) before the IN-SET workshop and high self-efficacy beliefs (MS = 4.0) after the IN-SET workshop. With regard to the premises on perceived competency to handle JHS Classroom activities there are significant differences between JHS science teachers' self-efficacy beliefs after and before the IN-SET workshop in all the item responses.

In order to ascertain the impact of the IN-SET workshop for the study on science teachers' self-efficacy beliefs towards teaching JHS basic electronics, t-test analyses for paired (dependent) samples were determined on the mean scores. The t-test was to establish the significant difference between the pre- and post-workshop mean scores. The t-test results are presented in Table 2.

Table 2: Overall JHS Science Teachers' Self-Efficacy Beliefs and t-test Analysis of Paired Samples

Category	Pre-Wk MS (SD)	Post-Wk MS (SD)	T-test results t-test	df	p-value
Overall Self-efficacy beliefs mean Score	3.4(0.70)	4.0(0.43)	6.02	45	0.000

N = 46, MS =Mean Score; SD= Standard Deviation in parenthesis

The results in Table 2 indicates that generally, JHS science teachers in JHS Kassena Nankana Municipal had expressed moderate self-efficacy beliefs (MS = 3.4) towards teaching JHS basic electronics before they attended the IN-SET workshop. However, after the IN-SET workshop JHS science teachers had shown high self-efficacy beliefs (MS = 4.0) towards teaching basic electronics. It is further indicated in Table 2 that there is significant difference between JHS science teachers' self-efficacy beliefs after and before the IN-SET workshop. Hence the IN-SET workshop has had positive impact on JHS science teachers' self-efficacy beliefs towards teaching basic electronics in JHS of KNM.

Research hypothesis 1

H_1: There is no significant change in the JHS science teachers' self-efficacy beliefs towards basic electronics after an IN-SET programme

Again, Table 2, which presents a t-tests analysis of paired samples scores shows that statistically, there was significant difference [t(45) = 6.018, p= 0.000] between the JHS science teachers' self-efficacy beliefs overall mean scores before (M= 3.4) the IN-SET workshop and after the IN-SET workshop (M = 4.0).

Therefore, the null hypothesis that, "there is no significant change in the JHS science teachers' self-efficacy beliefs in basic electronics after an IN-SET programme" was rejected. Hence, it can be concluded statistically, that there is significant changes in the JHS science teachers' self-efficacy beliefs towards teaching JHS basic electronics after they attended an in-service workshop on the JHS basic electronics.

Research question 2

What are the differences in JHS Science Teachers' Level of Content Knowledge (Competencies) in Basic Electronics before and after an IN-SET workshop?

JHS Science Teachers' Level of Content Knowledge (Competencies) in Basic Electronics before and after an IN-SET workshop

The pre-test and post-test were used to measure teachers' content knowledge competencies. The items determined teachers' ability to identify, name, and state the functions of basic electronics components used in JHS.

An average of 14.7% of science teachers were able to correctly identify all the major six circuit symbols (resistor, capacitor, inductor, transistor, LED, P-N J Diode) of JHS basic electronics before attending the workshop. However, an average of 91.3% of science teachers identified all the six major circuit symbols of JHS basic electronics after they had attended an IN-SET workshop.
With regard to the teachers who correctly identify pictures of basic electronics components, an average of 27.5% of JHS science teachers correctly identified all the pictures of the major six basic electronics components before they attended the IN-SET workshop. However, an average of 96% science teachers correctly identified all the pictures of JHS basic electronics components after attending the IN-SET workshop.

Also, 28.2% of JHS science teachers correctly stated the functions of the six (6) basic electronics components before attending the IN-SET workshop. Nonetheless, after the IN-SET workshop, an average of 91.0% of all science teachers did relate correctly the basic electronics components to their functions.

On the issue of science teachers who correctly related scientific units to basic electronic components, it was realized that, before the IN-SET workshop an average of 32.4% (15) of the teachers were able to correctly name all the terminal pins of the transistor and all symbols of scientific units used in JHS basic electronics components and circuit diagrams whereas on the average about 87% (40) of the science teachers named all the symbols in the circuit after the IN-SET workshop.

Also, about 81% of JHS science teachers were able to correctly relate all the auxiliary electronics circuit components (conductor, cell, breadboard, circuit diagram crocodile clips) to their functions after the IN-SET workshop as against about 32% before the IN-SET Workshop.

Table 3 displays the JHS science teachers overall mean percentage scores in content knowledge competencies assessments before and after IN-SET workshop on JHS basic electronics.

Table 3: JHS science teachers overall mean percentage scores in content knowledge competencies assessments before and after in-set workshop on JHS basic electronics

JHS science Teachers' CKC	N Sample	Mean Percent Score	S D
Before IN-SET workshop	46	32.8	22.86
After IN-SET workshop	46	89.9	8.49

The difference in overall CKC mean percent scores of the science teachers is 57.1% in favour of the post-workshop mean scores.

Research hypothesis 2

H_0: There is no significant improvement in the JHS science teachers' content knowledge (competencies) in basic electronics after an IN-SET workshop.

Table 4 shows the results of t-test analysis on JHS Science Teachers Content Knowledge Competency Scores before and after attending workshop.

Table 4: Results of t-test analysis on paired samples of JHS Science Teachers Content Knowledge Competency Scores before and after attending workshop

Science Teachers' CKC	MS (%)	SD	t-test	df	P
Before IN-SET workshop	32.8	22.86	16.547	45	0.000
After IN-SET workshop	89.9	8.49			

N = 46; MS = mean Score, SD = Standard deviation

The result of the t- test showed that statistically there was significant difference (t(45) = 16.477, p = 0.000) between the teachers content knowledge competency mean scores before IN-SET (MS = 32.8%; SD = 22.86) and after IN-SET (MS =89.9%; SD = 8.49). Therefore, the null hypothesis was rejected. Hence it can be concluded that statistically there was significant improvement in JHS science teachers' content knowledge competency in JHS basic electronics after attending the in-service training workshop.

Even though our *t*-statistic is statistically significant, it does not mean our effect is important in practical terms. To discover whether the effect is substantive we need to know about the effect size, *r*. Hence, r, was determined using the equation:

$$r = \sqrt{\frac{t^2}{t^2 + df}} = \sqrt{\frac{16.547^2}{16.547^2 + 45}} = 0.927$$

Hence *r*=0.927 represents a very large effect above 0.500, the threshold for a large effect. Therefore, as well as being statistically significant, this effect size is large and so represents a substantive finding.

The results of the statistical analyses of the teachers' pre- and post-workshop mean scores showed that the changes in teachers did not occur just by chance. Therefore, the significant positive change in the levels of the JHS science teachers' self-efficacy beliefs towards teaching JHS basic electronics and content knowledge competency in basic electronics after the workshop was an influence of the IN-SET workshop.

CONCLUSIONS

The findings of the study had shown that the IN-SET workshop had positive impact on JHS science teachers in JHS of Kassena Nankana Municipality. The IN-SET workshop enabled them to develop high self-efficacy beliefs and high level of content knowledge competencies towards teaching the scope of content topics in basic electronics sampled for the study.

RECOMMENDATIONS

- Based on the findings JHS Science teachers should be given regular and specific content knowledge (in basic electronics) science education in-service workshops. These workshops are likely to boost science teachers' self-efficacy beliefs and content knowledge competency in the specific content area; thereby, influencing their effectiveness to teach specific task areas in basic electronics (sciences).
- Since other contextual factors affect the development of science teachers' CKC, the Municipal/District Education Directorates should ensure that science teachers are offered science curriculum material as required by the current (existing) syllabuses to teach basic electronics.

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APPENDIX 1
Teacher's Personal Self-Efficacy Beliefs

Please, *tick in the columns* using the Likert scale to indicate the level of agreement with the statements in the Table The SD = Strongly Disagree-1; DA = Disagree-2; UD = Undecided-3; AG = Agree-4; SA= Strongly Agree-5.

No.	Item Statement	SD (1)	DA (2)	UC (3)	AG (4)	SA (5)
1.	I have self-motivation that I can teach the contents of basic electronics in JHS.					
2RC	I need more content knowledge so I can identify discrete basic electronics' components used in JHS.					
3	I believe I can teach JHS basic electronics if I study more on it.					
4RC	I believe that JHS basic electronics should be taught by special science teachers.					
5	I can devote adequate time to study basic electronics before my science lessons in JHS.					
6	I believe I have adequate content knowledge to teach basic electronics in JHS.					
7	I can confidently carry out hands-on activities on basic electronics with pupils in JHS.					
8	I can confidently solve pupils' difficulties in learning basic electronics in JHS.					
9 RC	I believe the practical activities of basic electronics are difficult to teach in JHS.					
10	I can confidently draw basic electronics circuits as required by the JHS science syllabus.					
11	I can confidently answer evaluation questions on JHS basic electronics.					
12	I can confidently say that basic electronics in JHS science syllabus is easy to teach.					
13RC	I cannot teach basic electronics in any of my science lessons in JHS.					
14RC	I can teach only some portions of basic electronics in my science lessons in JHS					

APPENDIX II
SAMPLE OF THE IN-SET WORKSHOP MANUAL FOR JHS SCIENCE TEACHERS

Teacher activity 1.0: JHS 1 - Basic electronics
Each exercise has its objective to be achieved according to the JHS Syllabus
Exercise 1.1: To explain the terms in JHS basic electronics

i. What is electronics? ....
....

ii. Mention the importance of the ff. in the electronic circuit
 a. Connecting wires (conductors) ....
 b. The switch ....
 c. The (dry) cell ....

iii. Examine various types of components given to you in the kit
 a. By what feature(s) would you identify the negative and positive terminals on a LED? ....
 b. By what feature would you identify the negative and positive terminals on the general purpose silicon P-N junction Semiconductor diodes? .... ……….................

c. How many Colour code bands has a normal fixed carbon-ceramic resistor? ....

d. By what feature would you identify the positive and negative terminals on the Capacitors? ....

iv. Draw the circuit symbols of these basic electronic circuit components.

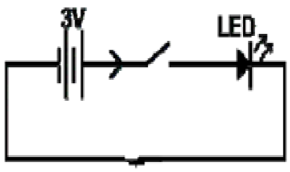
a. Resistor ....
b. LED ....
c. Capacitor ....
d. Transistor ....
e. Inductor ....
f. The cell ....
g. Diode ....

v. Identify the Positive (P) region and Negative (N) region of the general purpose P-N junction diode provided. What feature of the diode guided you? ....

vi. Use pictures/video clips to enable the teachers to observe various electronic components.

Exercise 1.2: To demonstrate the behavior of LED in d.c. electronic circuit

i. Connect a simple electronic circuit comprising a 3V battery made of two dry cells in series with a switch and an **LED** as shown.



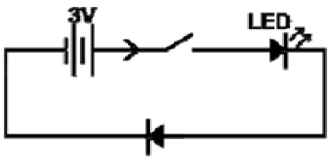
ii. Close the switch and observe. Write down what happens to the LED. ……………………….. …………………………………………………………..

iii. Open the switch and observe. Write down what happens to the LED. ………………………….......................................…

iv. Therefore, what is the **main purpose** of the LED in the JHS basic electronic circuit? ....

Exercise 1.3: To demonstrate the behavior of PNJ diode.

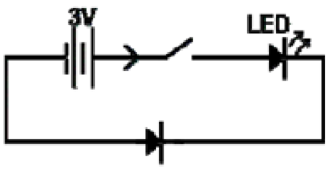
i. Connect a 3V battery, a switch, P-N junction diode and an LED in series as shown in the diagram.



ii. Close the switch and write down what happens to the LED in the forward bias of the PNJ diode ....

iii. Hence explain the term Forward bias of a PNJ diode...…......................................……………...... ....

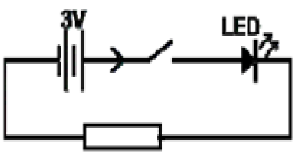
iv. **Reverse** the P-N junction diode terminals connection as shown in the diagram. Close the switch and write down what you observe happens to the LED in the reverse bias of the PNJ diode ....



v. Hence explain the term **Reverse Bias** of a PNJ diode**.** ....

Exercise 1.4: To demonstrate the behaviour of resistor.

i. Connect a 330Ω **resistor** in place of the P-N junction diode in the series circuit as shown in this circuit. Close the switch and observe.



ii. Write down the level of brightness to the LED. ....

iii. Replace the 330Ω resistor with a **higher resistance** of 3,300Ω (3.3k Ω). Write down current level of brightness of the LED? ....

iv. Explain why there is a change in the brightness. ....

v. Therefore, what is the function of the resistor in the electronic circuit? ....