International Journal of Materials Chemistry and Physics
Vol. 7, No. 1, 2021, pp. 5-13
http://www.aiscience.org/journal/ijmcp
ISSN: 2471-9609 (Print); ISSN: 2471-9617 (Online)

Knowledge Base of Chemistry Teachers' Support Materials Used in Teaching Practical Skills in Titration in the Senior High Schools in Ghana

Justice Asmah[1, *], Kennedy Ameyaw Baah[2], Mark Prince Kwamena Eghan[3]

[1]Department of Science, St. Vincent College of Education, Yendi, Ghana
[2]Department of Science, Wesley College of Education, Kumasi, Ghana
[3]Department of Science, Komenda College of Education, Komenda, Ghana

Abstract

The study focused on knowledge Base of chemistry Teachers' Support Materials used in Teaching Practical Skills in Titration in the Senior High Schools in Ghana. The purpose of the research was to develop Teacher Support Material for the teaching of laboratory practical skills of Observation, Communication, Listening and Manipulation of equipment in simple acid-base titration. The population for the study were chemistry teachers and students in three Senior High Schools (Edinaman, Komenda and Eguafo) in the municipality. Convenient, purposive and simple random techniques were used to the municipality, schools, teachers and students for the study. The (six) 6 teachers were purposively sampled out of the total of 8 chemistry teachers because they had qualification in Science Education in Chemistry. Five (5) students each were randomly selected from every SHS in the municipality. The study concluded that, the practical skills (PS)-based teacher support materials designed for use in teaching fundamental skills of observation, listening communication and manipulation of equipment in titration was a way of showing Senior High School Chemistry teachers how to develop these essential science process skills in teaching titration. It is recommended that, Ministry of Education, Ghana Education Service and Ghana Association of Science Teaching (GAST) must ensure that Senior High Schools chemistry teachers are taught how to use the Practical Skills-based Teacher Support Materials (TSMs) to enable them develop practical skills of Observation, Listening, Communication and Manipulation of apparatus in their students as they teach titration.

Keywords

Knowledge, Chemistry, Teacher Support Materials, Practical Skills, Titration

Received: June 24, 2021 / Accepted: July 22, 2021 / Published online: August 9, 2021

@ 2021 The Authors. Published by American Institute of Science. This Open Access article is under the CC BY license.
http://creativecommons.org/licenses/by/4.0/

1. Introduction and Background

One of the many definitions of science is that science is a special way of employing, asking, investigating and answering the world around us with the purpose of learning more about and understanding it better, and the only way of appreciating the process is to do it [1]. Ziman's definition suggests that the only way to appreciate science is through the process of doing it. The doing aspect of teaching and learning of science is therefore very necessary. In Senior High Schools in Ghana, the major science subjects (elective science subjects) are Chemistry, Physics and Biology. Each of these is practical oriented. Chemistry is an experimental science and its development and application demand a high standard of experimental work [2].

Experimental work helps develop in the young scientist the

* Corresponding author
E-mail address: bordohlity@yahoo.co.uk (J. Asmah)

positive attitudes and values which include curiosity to explore their environment and question what they find, keenness to identify and answer questions through investigations, creativity in suggesting new and relevant ways to solve problems, open-mindedness to accept all knowledge as tentative and to change their view if the evidence is convincing. Students also learn honesty, truthfulness and accuracy in recording and reporting scientific information as well as love, respect and appreciate nature and desire to conserve natural balance [3]. These positive attitudes and values are developed as students demonstrate the experimental skills of observation, manipulation, classification, drawing, measurement, interpretation, recording, reporting, and conduct in the laboratory/field [4]. Despite these benefits, practical work in SHSs faces the unfortunate problem of lack of resources, modern equipment and infrastructure among others.

Over the years, various attempts have been made at improving upon laboratory practical work in our schools. One classic example is the introduction of the Science Resource Centre (SRC) project. The Government of Ghana through the Ministry of Education (MOE) and Ghana Education Service (GES) in collaboration with Philip Harris Education in United Kingdom in the 1980s established and stocked 110 SRCs, one in each district to enhance practical teaching and learning of science through the provision of science apparatus as well as computers and other electronic equipment [5]. The Resource Centre project was an intervention that selected one SHS in each of the then 110 districts as the Centre School. The laboratory of the selected school was stocked with the necessary laboratory equipment and basic material so that the other SHSs in the district, the Satellite Schools, could visit for practical lessons.

Despite these interventions, teaching of science and technology has not seen much improvement in our SHSs. Most of SRCs are highly under-utilized. Research has even proven that most of the satellite schools no longer patronise these SRCs [6]. A visit to many of these SRCs reveal that most of the chemicals are left to expire (Asmah, 2007) confirming the fact that either little practical activity goes on in the schools or practical activities in the schools are simply less effective. Modes of teaching science in Ghana continues to encourage memorisation instead of understanding and application. Students have persistently performed poorly in practical sciences in the West Africa Senior Certificate Examination (WASSCE) [7, 8]. Students simply lack the ability to apply basic concept and principles because there is no adequate understanding of the subjects' content matter [9, 10-13]. A press review report in Ghana's authoritative newspaper "*Daily Graphic*" states that 'the universities are not churning out graduates who have the competencies and skills to enable them perform and become self-employed because little practical work is done in the universities' [14].

As if to respond to these criticisms, a number of researches have gone on in recent times and have all gone to recommend the need for improving upon practical activities in our schools. Scientific studies recommend that, senior high school students be given more opportunity to engage in laboratory, hands-on activities to enable them develop skills for planning, performing and reasoning. A recommendation which seems to suggest that within practical work itself lays the ability to learn to reason, plan and to perform [15, 16-17]. However, the assumption that practical work *per se* is a 'good thing', it opens to criticism. The researcher went further to say that, 'although practical work provides opportunity for students to engage and influence their own learning, learning with practical work remains a complex issue which needs further research' [18]. Just performing hands-on activity may not lead to an improved performance in science. Scientific skills may be more than the 'mechanical' aspect of practical work. They may extend to those processes of predicting, observing and interpreting and may be transferable to new contexts [19]. Learning these skills especially in laboratory setting may necessarily require support and guidance. For such an environment, the primary responsibility of the teacher is to create and maintain a collaborative problem solving environment where the students are allowed to construct their own knowledge and the teacher act like a facilitator or guide. For teachers to act as good facilitators therefore, the provision of Teacher Support Materials (TSMs) which will assist the teacher in the creation of that enabling environment within which the students can interact to construct the intended knowledge may be very necessary.

Over the years, the performance of SHS students in the practical examinations has shown lack of understanding in basic science concepts and principles. The Senior Secondary/High School Certificate Examinations chief examiners' reports [9, 10-14] have shown evidence of either little or ineffective practical work in the senior high schools. While the SHS science syllabus encourages practical work, no specific teaching approaches seem to be prescribed. In addition, there are no Teacher Support Materials (TSMs) or any such thing as practical teaching model that may serve as a guide to the teaching of practical skills for example in titration. As a result, science teachers are burdened with additional responsibility of creating and trying different approaches on their own, a possible reason for little practical work and poor performance of students in SHSs in the sciences. The purpose of the study was to develop Teacher Support Material (TSM) that could help science teachers improve upon the teaching of laboratory practical skills in titration. The study sought to answer the research question -

What type of laboratory practical teacher support materials (TSMs) could be used to teach practical skills of observation, listening, communication and manipulation of equipment in titration?

2. Review of the Literature

2.1. Constructivism Approach-the Role of the Teacher

Constructivist sees the teacher as a leader and a facilitator. 'The teacher recognises the students' potential and help them in the right direction at the right time' [20]. He is of the view that a constructive approach is oriented on construction of knowledge, by putting students in practical situations under the guidance and tutelage of the teacher. He shares the belief that learners construct their own knowledge through interaction and the assumption that ''knowledge is physically constructed by learners who are involved actively in the learning process'' [21]. In a situation such as this that knowledge is constructed in social environment where interactions is considered to be a basic factor for effective teaching learning process, the role of the teacher cannot be neglected rather it becomes more significant in terms of guiding students to selecting appropriate activities for learning. The teacher serving as a facilitator or a guide represent a conscious attempt by the teacher/instructor to remove himself or herself from the ''centre'' of the teaching-learning process such that the learner will work towards the point where the teacher becomes almost non-existent [22]. This is what Montessori describes as decentralization. The decentralization of education removes the privileged role of teachers within a classroom and is compatible with the idea that the teacher is not an absolute authority on the course material. Instead, authority is shared so that the students may engage and critique the education they are undertaking [23]. It could be inferred that one of the many outstanding aspects of the teacher is to create environment conducive to both self-directed individual's learning and cooperative group learning; the decentring of the teacher; and the sequential, progressive skill development.

2.2. Teacher Support Material

As the name suggests, Teacher Support Materials (TSM) are all materials that helps / facilitate teaching. It includes teaching syllabus, curriculum materials, teacher handbooks, teaching charts and models, textbooks, workbooks, worksheet and many more. It as a catalyst; any substance that alters the rate of chemical reaction without being consumed [24]. Ottevanger opines that teacher support materials are indispensable to teaching as catalyst is to chemical reactions.

> *In a chemical reaction, reactants have to get across an activation barrier in order to form a new product or products. This barrier can be overcome by an increased input of energy or by the use of catalyst to actually lower the barrier to be overcome. The use of catalyst is indispensable as they allow reactions to take place faster and easier without the need of expending additional energy [24].*

It is also obvious from Ottevanger's assertion that TSMs do not take part in the lesson but only support in other to lessen the burden on the teacher in planning, delivery, concluding and even assessing the lesson. Again, Ottevanger's assertion also suggests that the absence of TSMs would not only make teaching and learning extremely difficult but almost impossible.

2.2.1. Developing Teacher Support Material

Three characteristics for development of Teacher Support Materials. These include

1) local conditions and circumstances in which the TSM will be used,
2) function of the material and
3) Allowance for transfer [24].

The local conditions are essential in developing TSMs. He states that just as 'local conditions and circumstances in which catalyst would do its work need to be taken into account during development, developments of support materials need to take account of the local conditions and circumstances in which they will be used' [24]. Materials 'will have to be developed with a clear view of the implementation conditions with the teacher and the class in mind' [24].

2.2.2. Functions of Teacher Support Material

Teacher Support Materials

1) Reduce the complexity of innovations and initial extra workload for teachers.
2) Provide teachers with clear and practical ideas for lesson execution and support.
3) Support teachers with varying levels of competencies in schools with varying degrees of organization.
4) Provide initial positive experiences with innovation in order to build understanding and support in changing attitudes and believes [24].

The teacher support materials lead to well organized lessons in the majority of cases. It gives teachers plan for the lesson and makes them feel well prepared for the lessons. After successful development and implementation of curriculum support material in Namibia, stated that:

> *Equipment, materials, and worksheets were ready before the start of the lessons.......Teachers felt that most of the lesson planning had already been done for them. Some teachers were very helpful in understanding what needed to be achieved during the lesson. In addition, teachers mentioned that the support materials had been useful as a resource with extra information on the topic of the lesson [24].*

It is evident from his conclusion that TSMs should motivate teachers in lesson delivery. After investigating to integrate Indigenous Technology into the teaching of Science, a researcher identified among others, the following characteristics for Indigenous Technology-oriented Science Teaching Approach-based TSMs: they must

1) be content laden or full of information,
2) give guidance to the teacher,
3) be systematically put together and easy to use,
4) be practically oriented and should contain lots of pleasurable activities,
5) be time bound [5].

Teachers Support Material must be resourceful to the teacher in terms of providing information, guiding lesson presentation as well as fully involving the learner in the teaching learning process [5, 24].

2.2.3. Teaching Practical in the Laboratory

Practical work is a prominent and distinctive feature of science education. It has a number of importance in science:

1) It helps students develop science process skills such as observing, classifying, predicting, measuring, drawing, recording data, hypothesizing, etc.
2) It promotes the development of scientific attitudes such as objectivity, honesty, curiosity, patience, open-mindedness, etc.
3) It helps students to understand and appreciate the spirit and methods of science such as problem solving, analytic minds and methods of science.
4) It is used to reinforce what is learnt in the theory class and hence encourages the spirit of experimentation.
5) It arouses and maintains interest and curiosity in chemistry.
6) It helps students to develop manipulative skills and proficiency in writing reports.
7) It enhances students' better understanding of concepts and principles and by so doing, significantly contributes to students' achievements in chemistry.
8) It encourages students to be active in the class, on the other hand, discourages abstraction, rote memorization and inattentiveness in the class.
9) It leads to fundamental and applied research in chemistry at all levels of education [25].

Many science teachers and others see practical work carried out by the students themselves as an essential element of good science teaching. It is widely accepted that science is all about practical work [26]. Practical work is central to teaching and learning in science and that good quality practical work helps develop students' understanding of scientific processes and concepts. It also encourages accurate observation and description; makes phenomena more real; arouses and maintains interest; promotes a logical and reasoning method of thought.

2.3. Observation

Observation is done by different people in different fields for different purposes. In medicine (e.g psychiatry), client is observed among other things for; Understanding the patient's situation, identifying signs of pathology, developing a therapeutic plan and Monitoring its application and the evolution of the patient [27]. In the classroom, teachers observe learners to judge how effective their own efforts have been. They may find, for example, that one method of responding to a child's undesirable behaviour causes the behaviour to increase, while another causes it to decrease. Also, they better understand how different areas of development are interrelated. Activities and skills are hardly purely physical or purely social, emotional, or intellectual. Most are mixture. [28]. Observation in the laboratory is also very important. It is the very first and most fundamental of all the process skills. It holds the key to scientific discoveries. In other words, scientific discoveries begin with observation. Observation is the use of the five senses to derive characteristics of living organisms [29]. To observe therefore does not mean same as to perceiving.

The Senior High School (SHS) chemistry teaching syllabus stresses the use of the senses to make accurate observations. The students for instance, should be able to tell the colour, form, texture and the structure of specimens provided and be able to classify those [30]. Observation is a two-part process. First *describing* what has been seen and then *interpreting* what it means. The mind almost simultaneously processes a visual image, integrates that image with previously stored images related to satisfactory and unsatisfactory experiences, and ascribes a value or meaning to that image. If a student yawns, our mind signals "boredom." If a teacher yells at students, our mind registers "losing control." A judgment derives from an image or a description of events. Care must be taken not to split that almost simultaneous process, of separating description from interpretation. When the description of the event is lost and only the interpretation is retained, communication difficulties and obstacles to improvement are created. Sharing the description of events is the forerunner of professional improvement. Interpretation leads to resistance. When both parties can agree on what events occurred, they are more likely to agree on what needs to be changed. In observing, the focus is on watching and sometimes, listening not talking [28].

2.4. Listening Skills

Listening is almost a neglected communication skill. This void in our education is especially interesting in that most of us spend seven of every ten minutes we are awake in some form of communication activity. Out of this, about 45 percent goes into listening [31]. Effective listening is a specific skill that can be consciously developed and practised in various workplace situations. Listening is not simply a matter of hearing. Listening is an active psychological rather than passive process, which enables us to attach meaning to all the information we receive. It requires concentration and effort. As we listen to others we interpret and evaluate the meaning from the verbal and non-verbal information that we receive [32]. We also plan and rehearse our response in preparing to execute it. While the processes of evaluation, planning and rehearsal occur subconsciously, they can nevertheless interfere with effective listening. It can be important to maintain awareness of this to ensure that the processes that mediate between listening and speaking do not actually interfere with the listening process itself. Developing effective listening skills involves two specific steps [33]. These are:

1) To develop the ability to recognise and deal with barriers that prevents you listening with full attention.
2) To develop and use behaviours which help you to listen. Such behaviours can also serve to let the other person know that you are giving them your full attention.

2.5. Communicating

Communicating can take many forms including using words, actions, posters, diagrams, pie-charts or graphic symbols to describe an action or event [34]. The skill of communicating results needs to be mastered as a process skill when learners report on the group's procedure and the results obtained. This process skill may also involve a situation in which the learner comments on observations and responds to the focus question. When learners have completed an investigation it is important that they reflect on the procedure and experimental design by identifying the difficulties they experienced in doing the investigation and reflecting on how they could improve the same investigation in terms of fairness and accuracy [35]. The process skill allows the learner to actively evaluate their own and others learning. Communication requires learners to share the information they have gathered from observations with the rest of the class. The process skills help the learners to reflect on their own learning and to build confidence in themselves [34-35]. On the surface the above process skills may appear to be reasonably uncomplicated, but the complexity comes in during the implementation.

3. Methodology

A qualitatively, interpretative design was adopted to evaluate type of laboratory practical Teacher Support Materials could be used to teach practical skill of observation, listening and communication and manipulation of apparatus in titration. The population of the study consisted of three public Senior High Schools (SHS) in Komenda Edina Eguafo Abirem (KEEA) municipality of the Central Region of Ghana. Each school offers chemistry as a subject to students. The targeted population for the study were teachers and students in all these SHSs. There were a total of eight (8) chemistry teachers in all these three SHS, all of them were males. All had graduated from the university with a first degree in Science, except two (2). had B.Sc. in Environmental Science. Convenient, purposive and simple random techniques were used to the municipality, schools, teachers and students for the study. The (six) 6 teachers were purposively sampled out of the total of 8 chemistry teachers because they had qualification in Science Education in Chemistry. Five (5) students each were randomly selected from every SHS in the municipality. The main instrument used for data collection was semi structured interview guide, Teacher interview schedule was used to solicit information from the chemistry teachers on how they perceived the use of Practical Skills-based TSMs for teaching practical process skills in titration at the SHS levels. Interview sessions were used to collect data on the characteristics of teacher support materials that could be used to teach practical skills in titration. The data were analysed by putting into groups, the trend of responses and qualitatively describing the trends of emerging themes.

4. Findings and Discussions

Two chemistry teachers sampled from each of the three trial schools (TS1, TS2, and TS3) were interviewed. The interview centred on the general impression of the teachers about the characteristics of the materials they used and the activities carried out during the lessons. It also asked for the aspects of the materials that they liked or dislike, possible problems relating to the duration of the lesson and any other suggestion to improve the Practical Process Skill based (PS) TSM. The responses of the two teachers, Teacher 1 (T1) and Teacher 2 (T2) in TS1 were the first to pool together and analysed. The responses which formed the basis for the development of the model from V0 to V1 was categorized and presented based on trends of the responses as follows; both teachers said that TSMs are anything that helps the teacher in delivering his lesson successfully when they were asked what TSMs are. When they were asked which type of TSM they were using to teach practical chemistry, while Teacher 1 (T1) said he uses the syllabus together with the Ghana Association of Science Teachers (GAST) textbook, the other, Teacher 2 (T2), said he uses a hand-out called 'Kosooko' and the syllabus. When they were asked exactly what TSM do for them, they both agreed that it gave them information and guided them as to what to teach.

Then they were asked whether the PS-based TSMs were useful, and again they both said it was useful. Teacher 1 (T1) said the TSM made students understand the lesson better and teaching was made easier because the model provided a guide for the teaching. Teacher 2 (T2) also said that it was useful because it directed the teacher as to what to do. "Using it, one does not need to look for any other material," T2 added. When asked about their general impression on TSM, T1 said that it was simply good. He said it made him teach some little things that he might ordinarily overlook. He was however of the view that it took too much time using the TSM. Teacher 2 (T2) on the other hand simply said it was fantastic. He said apart from the fact that he did not need to go round looking for any hand-out, using the guide also helped him to attract and hold the attention of the students. T2 was also of the view that it took much longer time to go through the model than he would have done on his own but was very quick to add that it was worth it. "We had always assumed that these practical skills are acquired naturally but after using the model, I now think otherwise", T2 added.

When researchers went further to ask how they thought students' ability to observe, listen and communicate could be developed, TI said "*students should be engaged in activities that would require the use of all their senses*". T2 also said "*teachers must include in their mode of assessment correct observation, good listening and communication skills so as to encourage the young scientist acquire these skills*". 'Your model is a fairly good attempt at achieving this.' T2 added.

From the dialogue, it was gathered and deduced that a good TSM to teach practical skill must be knowledge based, chronologically designed and sequentially presented. It must be easy to understand and must provide enough guides to the teacher. It should also be activity oriented.

After conversation with the teachers, five students; two boys and three girls from trial school 1 (TS1) were also engaged in focus group discussion on all the lessons. The discussion focused on what they liked and did not like about the lesson and whether the lesson enabled them to observe, listen and communicate better than before. The students said that the method was useful to them. They said in the 1st station lesson (observation), when they were asked just to observe and not to ask any question but could write down and look for answers for discussion later, they initially felt uncomfortable but later became curious and attentive. On the third stair (communication), one student said 'for a moment, I thought we were learning English when we were made to pronounce words and look up for their meanings.' All the students unanimously agreed that when it got to the stair-five (manipulation stage); they felt so relaxed as if they were playing. They again liked the idea of allowing them time to use water to learn to pipette before using acid and the base. At the end of the trial 1, the following major characteristics were identified. TSMs for teaching practical skill must be;

1) Knowledge-based and filled with information.
2) Systematic in presenting from less difficult to more difficult activity.
3) Easy to understand by whoever uses it.
4) Such that they provide enough guides to the teacher.

Trial School 2 (Model V1)

After the trial of the PS-based TSMs in the trail school 2, again two other teachers and five students were interviewed just as it happened with the trial school on (TS1). Both teachers, Teacher 1 of school 2 (T1S2) and teacher 2 of school 2 (T2S2) agreed that the TSMs were very useful to them. They agreed that it gave them enough information that they did not need any other hand-out or textbook to refer to before they could teach titration. Both of them said they do organize practical titration lessons from time to time but could not tell with certainty either once or twice a week. However, when they were asked about their interest in practical work, T1S2 said he likes practical work even though it is often time consuming. However, T2S2 openly said he did not like it that much. He does it because he had to do it. His reasons were that apart from its being time consuming; it exposes the teachers to hazardous chemicals without any allowance. When they were asked of their knowledge on TSMs, they both said that it does help a lot in teaching but they did add that they did not have many of them for teaching titration except the syllabus "and the syllabus itself is not detailed enough" T1 added. Again I inferred after the conversation that the PS-based TSM must contain enough information on titration.

The discussion went further when the question of the usefulness of the PS-based TLM was put to them. T1S2 had a lot to say. He said the PS-based TSM was very useful because they had more information that could not be found in the syllabus. 'It is a valuable resource. Using it, one teaches more than just how to carry out titration. One learns even how to communicate and it is very important,' T1S2 added. T2S2 also said it was useful because students were engaged in activities to observe, listen, and communicate and correct handling of titration apparatus. Both of them however agreed that using it was time consuming.

Researchers again asked the two teachers whether they would prefer to use the PS-based TLM to the usual way of teaching titration and both answered in affirmative. To S2T1, the model had well defined objectives which guided the teaching and made it easy. T2S2 on the other hand would prefer that to the usual way because "*at least the model guides me as to where to start and where to end the lesson*", he said. After talking to the teachers, as it happened in trial school 1, five students were engaged in focus discussion. The discussion which lasted for 20 minutes mainly focused on what they liked and disliked about the lessons. All of them said that they enjoyed the lessons. One of them said she enjoyed so much the stage where they performed the activity after the teacher had performed (Scaffolding. "I was so much afraid of acid because my mother had told me it could cause great harm but I can now handle it because of the activity", another girl added. One girl however suggested that an excursion be organized to one of the companies / factories where titration is used. It was inferred from her suggestion that to make learning a skill more entertaining, the learner could be made to observe not only in the classroom but on the real field where the skill is being used. The model must therefore bear an out-of-class characteristic.

At the end of 2nd trial at TS1, the following major characteristics were inferred. In addition to those identified in trial 1 earlier the PS-based TSM

1) Must be more activity oriented;
2) Must be time specific and economical;
3) Must have clearly stated objectives which are measurable;
4) Must consider observing the skill being learnt at the real workplace (field observation).

These recommendations together with others obtained from literature went into the development of the model from 1st version to the 2nd version (V1-V2).

Trial School 3 (V2)

This was the last stages of the trials of the model. The second version (V2) of the model was used by two teachers. Teacher 1 in school 3 (T1S3) and Teacher 2 in school 3 (T2S3) were interviewed after the lessons in an attempt to look for the characteristics of the PSB TSM that could be used to teach skills of observation, listening, communication and manipulation of equipment.

The teachers were asked of their knowledge in the use of the TSMs in teaching titration. T1S3 said that he had been teaching chemistry in SHS for the past five years and the only teacher support material he knows is the syllabus and the GAST textbook. "There are not many TSMs that direct me as to how practical skills could be taught in addition to the note I prepare and some hand-out", he added. He was of the view that the PS-based TSM is good because it does not only provide information, but it also provides a systematic procedure by which titration lesson could be taught. T2S3 on his part had this to say "your TSMs are simply good. It does not only teach titration but highlight on fundamental skills that we so often turn to overlook. Ability to make good observation alone is of paramount importance to the scientist. In fact, we need more of such materials in schools to give us alternative approaches of teaching specific areas of the syllabus". However, both of them admitted that one needs to study the TSMs very well before using it so as to appreciate its usefulness. It was gathered from the interview that the TSMs must be simple and easy to understand for it to be appreciated.

The teachers were asked whether they would recommend its use in schools. Both of them answered in the affirmative. TIS3 said it will be very useful in schools because it provides information, gave step by step guidelines to the teacher, and it is full of activities that could be used to teach titration without a search for any other material. T2S3 also said the material was useful because it was a detailed lesson plan. "It saves time and energy spent on looking through hand-outs which were often filled with mistakes. Expressing their general impression on the PS-based TSM, T1S3 said apart from the fact that it needs thorough reading and understanding before use, it is a very good material. The method of assessment used for the manipulative skills is the best procedure to measure skills. "These are the things WAEC should be looking at." he added. T2S3 simply said the material is fantastic. To answer the Research Question; What type of Practical Skills based TSMs could be used to teach practical skills of observation, listening, communication and manipulation of equipment, the following characteristics were identified as how the TSMs should look like;

1) It must be knowledge or information based.
2) It must offer systematic presentation of information from less difficult to more difficult information.
3) It must be activity based and student centred.

4) It must be easy to understand by the user.

5) It must provide enough guide to the teacher.

6) It must be more activity oriented.

7) It must be time specific.

8) It must have clearly stated objectives which are measurable.

9) It must have pleasurable pre-lesson activity for introduction and well-tailored evaluative activities.

The findings are in agreement with a similar study conducted in South-Eastern part of the Volta Region of Ghana to integrate indigenous Technology into the teaching of Science [5]. The teacher support materials must have enough information such that it will inform the teacher who uses it since most of the time the information given in the syllabus is not just enough. Again, it must show systematic process of teaching the skill because again the syllabus which is the primary guide of the teacher does not detail any step by step process to be followed to teach the practical process skill. Teachers are therefore often left to try anything in implementation of the syllabus. Most teachers even entirely forget about helping the learners acquire these essential skills but provide some information just enough to enable the students pass examinations as it came up during the interview. Through the direction for teaching that it offers, it is hoped that the PS-based TSMs would motivate teachers who use it to teach the skills of observation, listening, communication and manipulation of apparatus in titration.

5. Conclusion and Recommendations

The PS-based teacher support materials designed for use in teaching fundamental skills of observation, listening communication and manipulation of equipment in titration was a way of showing Senior High School Chemistry teachers how to develop these essential science process skills in teaching titration. It is recommended that, Teachers of Chemistry in particular (and science in general) must make conscious effort at developing process skills in practical lessons to make learning science more meaningful and interesting. It is also recommended that, Ministry of Education, Ghana Education Service and Ghana Association of Science Teaching (GAST) must ensure that Senior High Schools chemistry teachers are taught how to use the Practical Skills-based Teacher Support Materials (TSMs) to enable them develop practical skills of Observation, Listening, Communication and Manipulation of apparatus in their students as they teach titration.

References

[1] Ziman, J. (2000). *Real science: What it is and what it means.* Cambridge: Harvard University Press.

[2] Bennett, S. W., & O'Neal, K. (1998). Skills Development and Practical Work in Chemistry. *University Chemistry Education, 2,* 58-62.

[3] Ministry of Environment, Science, and Technology (2005). *Environment, science and technology*. Retrieved from Hppt:/www.mofep.gov.gh/?q=divisions/ pbb/environment-science-and…

[4] Ministry of Education. (2007). *Teaching syllabus for chemistry: Senior high school.* Accra: Curriculum Research and Development Division.

[5] Anthony-Krueger, C. (2011). *Integrating indigenous technology into science teaching in selected junior high schools in south-eastern Volta Region of Ghana.* Unpublished doctoral thesis, Department of Science and Mathematics Education, University of Cape Coast, Cape Coast.

[6] Ampiah, J. G. (2004). *Investigations into science practical work in senior secondary schools: Attitudes and perceptions*. Unpublished doctoral thesis, Department of Science and Mathematics Education, University of Cape Coast, Cape Coast.

[7] Ameyaw-Akumfi, C. (2004). *The promotion of science education in Ghana*. A paper presented at the first National Forum of Harnessing Research, Science and Technology for Sustainable Development in Ghana, International Conference Centre, Accra.

[8] Fruedua-Kwarteng, Y., & Ahia, F. (2005). *Ghana flunks math and science; analysis (2).* Retrieved from www.modernghana.comnews/72489/1/Ghana-flunk-math-science-analysis-2.htm.

[9] WAEC. (2003). *Chief examiner's report on senior secondary school certificate examinations*. Accra: Wisdom Press.

[10] WAEC. (2004). *Chief examiner's report on senior secondary school certificate examinations*. Accra: Wisdom Press.

[11] WAEC. (2005). *Chief examiner's report on senior secondary school certificate examinations*. Accra: Wisdom Press.

[12] WAEC. (2006). *Chief examiner's report on senior secondary school certificate examinations*. Accra: Wisdom Press.

[13] WAEC. (2010). *Chief examiner's report on senior secondary school certificate examinations*. Accra: Wisdom Press.

[14] Daily Graphic, (2007, April 12). *Another round of education reform.* Retrieved on August 18, 2009, From, http://WWW.GhanaWeb.comGhanaHomePage/NewsArchieve/artkel.php? ID=122323.

[15] Dadzie, A. (2011). *Assessing laboratory skills of selected junior high school students in selected integrated science topics.* Unpublished master's thesis, Department of Science and Mathematics Education, University of Cape Coast, Cape Coast.

[16] Naah, A. M. (2011). *Assessing Science Students' planning skills in selected topics from the senior high school integrated science syllabus.* Unpublished master's thesis, Department of Science and Technology, University of Cape Coast, Cape Coast.

[17] Salifu, M. M. (2010). *Assessing laboratory skills of physics students in selected senior high school topics in mechanics and optics*. Unpublished master's thesis, Department of Science and Mathematics Education, University of Cape Coast, Cape Coast.

[18] Toplis, R. (2011). *Student views about secondary school science lesson: The role of practical work*. Uxbridge: Brunel University Alumni.

[19] Wellington, J. J. (Ed.). (1998). *Practical work in school science: Which way now?* London: Routledge.

[20] Hussain, I. (2012). Use of constructivist approach in higher education: An instructors' observation. *Creative Education, 3.* Retrieved from *http://www.SciRP.org/journal/ce*

[21] Gagnon, G. W., & Colley, M. (2001). Constructivist learning design. *Creative Education*, 6. Retrieved from http://www.prainbow.com/cld/clds.html

[22] Sims, R., Dobbs. G., & Hand, T. (2001). *Proactive evaluation: New perspectives for ensuring quality in online learning application.* Conference proceedings of the 18th Annual Conference of the Australian Society for Computers in Learning in Tertiary Education (AS-CILITE), Melbourne.

[23] Montessori, M. (1912). *The Montessori Method*. New York: Stokes.

[24] Ottevanger, W. (2001). *Teacher support materials as catalyst for science curriculum implementation in Namibia*. Twente: Print Partner.

[25] Achimugu, L. (Ed.). (2013). Strategies *for effective conduct of practical chemistry works in senior secondary schools in Nigeria.* Ibadan: HEBN Publishers.

[26] Millar, R. (2009). *Analysing practical activities to assess and improve effectiveness: The practical activity analysis inventory (PAAI).* York: Centre for Innovation and Research in Science Education, University of York. Retrieved from http://www.york.ac.uk/depts/educ/research/ResearchPaperSeries/index.htm

[27] Phaneuf, M. (2007). Psychiatric observation: A Skill Worth Developing. *Clinic Crossroad under Psychiatric Care*, *25*, 56-59.

[28] Clark, P., & McDowel, G. (Eds.). (2000). *The developing child's observation guidebook*. New York, NY: McGraw-Hill.

[29] Ongowo, R. O., & Indoshi, F. C. (2013). Science process skills in the Kenya certificate of secondary education for biology practical. *Creative Education,* 4. Retrieved from http://www.scirp.org/journal/ce

[30] Ministry of Education. (2010). *Teaching syllabus for chemistry: Senior high school.* Accra: Curriculum Research and Development Division.

[31] Kline, J. A. (2008*). Listening effectively*. Alabama: Air Force University Press.

[32] Dixon, T., & O'Hara, M. (2012). *Making practice based communication skills*. A Resource Commission by making Practice-based Learning Work Project, an Educational Development Project, San Diego, CA.

[33] Hussein, L., Shehata, A., & Omer, E. M. A. (2018). Effective techniques used by teachers to improve English oral communication skills in Sudanese secondary schools. *International Journal of Information Research and Review, 05* (11), 5899-5909.

[34] Monhardt, M., & Monhardt, R. (2006). Creating a context for the learning of science process skills through picture books. *Early childhood Education Journal, 34* (1), 67-71.

[35] Ward, H., Roden, J., Hewlett, C., & Foreman, J. (2008). *Teaching science in the primary classroom.* (2^{nd} ed.). London: TJ International Ltd.