ACCESS, USE AND CHALLENGES OF ADOPTING TESSA SCIENCE OER BY BASIC SCHOOL SCIENCE TEACHERS IN GHANA

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ABSTRACT

The study was conducted to explore basic school Integrated science teachers' use of Teacher Education in Sub-Saharan Africa (TESSA) Open Educational Resources (OER), and the challenges associated with the use of the innovation during classroom instructions. A mixed method approach with sequential explanatory design was adopted for the study. The census sampling technique was used to obtain a sample of 134 basic school Integrated science teachers in the Effutu Municipality for the study. Data was collected using a questionnaire, interview guide and documents. The analysis of quantitative data involved the use of multiple statistical procedures; frequency counts, simple percentages, and standard deviation, while the thematic and content analysis approaches were used to analyse the qualitative data. The study revealed that 14% of the teachers often use the TESSA materials in their classroom instructions. The study also revealed that the contents of the TESSA science materials address the concepts in the Ghanaian Integrated science syllabus and hence promotes active learning among students. However, teachers indicated among other things that, the cost of internet data, time and inadequate knowledge to incorporate TESSA OERs into lesson plans were their major challenges. It was therefore recommended that hard copies of the TESSA modules should be provided to the teachers by the TESSA consortium or by the Effutu Educational Directorate to curb the cost involved in accessing the material for teaching.

Keywords: TESSA OERs**,** Basic school, Integrated science teacher, Open Educational Resources

INTRODUCTION

In recent times, Open Educational Resources (OERs) have emerged as an innovative teaching and learning tool as well as cost-effective resources that improve the quality of educational offerings globally (Kanwar, Kodhandaraman, & Umar, 2010). UNESCO (2012) defined Open Educational Resources (OERs) as any teaching, learning and research materials in any medium, digital or otherwise, that reside in the public domain or have been released under an open license that permits no-cost of access, use, adaptation and redistribution by others with no or limited restrictions to improve teaching and learning.

The commonly accessed OER by teachers, student teachers and teacher educators in Africa is the Teacher Education in Sub-Saharan Africa (TESSA) (Moon & Wolfenden, 2007). A consortium coordinated by The Open University, UK, created the TESSA OER and its curriculum stretches across that of nations in Sub-Saharan Africa (Moon & Wolfenden, 2007).

The TESSA curriculum is designed to support teachers and teacher educators in developing active approaches to learning and provides examples of participatory pedagogy. This wealth of OER materials and guidance is freely available to be used, downloaded, distributed, adapted and re-uploaded to the TESSA website. Users can also share opinions and seek advice through the TESSA Forum (Moon & Wolfenden, 2007).

The TESSA Science OER, which is the focus of this study is made up of both primary and secondary science units and were developed by science educators from Ghana, Zambia, Kenya, Tanzania and Uganda. The underlying advantage of the TESSA model as a site of professional learning is the support in making learning possible everywhere (Moon, Brown & Ben Peretz, 2000). Thus, teachers are able to continue to attend to their own learners whilst studying, integrating teaching and studying within their own context. One of the professional tasks of the TESSA OER in general and specifically that of the science units are aimed at integrating theory and practice that is centering on daily classroom practice to improve the effectiveness of teacher-pupil interactions in almost all the subjects taught in Sub-Saharan countries (Moon, Leach, & Stevens, 2005).

Higher education institutions that form part of the TESSA consortium have been successful at the implementation of the TESSA OER. Research work carried out on the impact of the material on teacher quality has been tremendous (Cullen, Keraro & Wamutitu, 2012; Harley & Barasa, 2012; Ngman-Wara & Acquah, 2015). In Ghana, the University of Education, Winneba implemented the TESSA OER by incorporating the innovation into some of the courses taught by Department of Basic Education and organised workshops to introduce basic school teachers in the Effutu Municipality to the use of TESSA OER (Acquah, 2015, Acquah, 2019; Harley and Barasa, 2012). Studies conducted on the use of the TESSA OER units in the Effutu Municipality revealed a positive attitude by both student teachers and basic school teachers towards the use of the innovation. The teachers indicated that the TESSA OER units improved their ability to teach science, promoted learner-centered approaches to teaching and enhanced pupils' science achievement (Acquah, 2015; Essuman, 2015; Ngman-Wara and Acquah, 2015). However, Acquah (2015) recommended that further research should be conducted on teachers' use of TESSA Science OER as less is known about Integrated science teachers' TESSA OER related practices in the Effutu Municipality. Therefore, this study set out to examine the access, use and challenges of adopting TESSA science OER by basic school Integrated science teachers.

The study was guided by the following research questions:

    1. How do basic school Integrated Science teachers in Effutu Municipality use TESSA OER in their school classrooms?

    2. What challenges do basic school Integrated science teachers face in using TESSA OER?

The study was situated within the frameworks of constructivism and diffusion of innovations model. These two frameworks focus on the pedagogical importance of TESSA OER, and the awareness and use of TESSA OER respectively. The theory of constructivism is the most philosophical basis to justify the use of TESSA OER. The TESSA Science materials promote activity -based learning and hence allow learners to develop their own concepts in the teaching and learning process.

Conversely, the TESSA Secondary Science is underpinned by the belief that active approaches to learning are likely to produce better outcomes for pupils than teacher-led lessons in which pupils are passive participants (Stutchbury & Ngman- Wara, 2012). Stutchbury and Ngman-Wara (2012), are of the view that the role of the teacher is to support pupils in constructing understanding, considering pupils' prior knowledge and experiences. Student teachers are

therefore taught sound constructivist principles but they find it difficult to apply in practice and often view these techniques to be separate from their 'real' teaching (Stutchbury & Ngman-Wara, 2012).

The study was also situated within the theory of Diffusion of Innovations (Rogers, 2003). In this theory, the mechanism of diffusion, the innovation adoption curve and the perceived attributes of innovation were addressed. Diffusion of innovations is a theory propounded by Everett Rogers that seeks to explain how, why, and at what rate new ideas and technology spread (Rogers, 1995). Rogers defined that diffusion is the process by which an innovation is communicated over time among the participants in a social system. According to Rogers (2003), adoption is a decision of full use of an innovation as the best course of action available and rejection is a decision not to adopt an innovation. Rogers defines diffusion as the process in which an innovation is communicated through certain channels over time among the members of a social system (Rogers, 1995). Thus, before any innovation comes into public view, it has to experience five stages, which are the stages of knowledge, persuasion, decision, implementation, and confirmation in order for it to be accepted or rejected by individuals in the social system; hence it is necessary to understand OER as an innovation in education, and that the adoption of TESSA OER is dependent upon various factors to move forward from the knowledge stage to the final confirmation stage (Rogers, 2003; Kissinger, 2011). Accordingly, there is also the need to explore the reasons that may prevent the movement of TESSA OER from the first stage (knowledge) to the last stage (use).

In a number of studies, the term "use" was employed to refer to copying original OER as well as adapting OER through some form of versioning or combining (remixing) (Hodgkinson-Williams, 2014). Oates, Goger, Hashimi, and Farahmand (2017) stated that most teachers use the OER to design their lesson plan effectively while some do not use any OER but rely solely on a textbook when preparing their lesson plans. This pattern is similar to Adala's (2017) study, which revealed that teachers used OER as a primary resource in their lesson plans while some of them supplemented and complemented their lessons with other sources (textbooks), and even sometimes to the extent that they may not necessarily take a primary position.

Again, some educators perceived that because OERs are free, they may be of poorer quality than the traditional, copyrighted educational materials sold by publishers (Boston Consulting Group, 2013). By contrast, other educators assume that OER would typically be of good quality because the materials are exposed to many experts who may critique the materials if not appropriate (Stacey, 2007). de Oliveira Neto, Pete, Daryono and Cartmill (2017) pointed out that the use of OER is low in Sub-Saharan Africa but comparatively in Africa, Ghanaian and Kenyan instructors had a higher OER use rate. In Sub-Saharan Africa including Ghana, most educators access the TESSA materials because the materials provide ideas for teaching, which is in line with the activity-based approach of their curriculum (Wolfenden, Auckloo, Buckler, & Cullen, 2017).

de Oliveira Neto et al., (2017) confirmed that few educators randomly adapt (modify) OER at least once. Several studies have indicated that though most teachers had experienced using OER, many of them still continue to rely on the student textbook to prepare lessons (Kasinathan & Ranganathan, 2017; Mishra & Singh, 2017). This contradiction may suggest that OERs are a deviation from entrenched practices and some teachers choose not to use OER despite having access to them. In spite of the factors that encourage teachers' use of OERs in classrooms, several studies have conducted empirical research on factors (barriers) that discourage the use of OER by teachers. Understanding the extent to which these barriers affect individuals and

institutions may help in deciding how they are to be tackled (Becta, 2004). According to Wiley and Hilton (2009), four common obstacles to OER use and contribution are:
• the amount of time necessary to put OERs in a format that can be shared;
• a desire to keep the resource from being seen by others;
• few of any external reward mechanisms for creating OERs; and
• the concern that nobody will want to use the OERs created.

The lack of internet facilities has been identified as a problem that affects teachers' access and use of TESSA OER (Shayo & William, 2015). Access to the internet is central and without it, individual use of OER is static. Many schools lack power and internet connectivity and therefore they do not promote OER use (Wambugu & Karero, 2015). Much of the reasoning around the selection of OER by educators was well understood on the fact that OERs reduce cost as compared to proprietary textbooks (Menon, Palachandra, Emmanuel & Kee, 2017). Contrary to this, the cost of internet for the access of OER has been confirmed to affect OER use (Herrera, 2010)

Several studies have revealed other challenges that affect the use of OERs, to include; infrastructure accessibility, time and internet bandwidth, teaching experience, and leadership support. In line with the findings of numerous previous studies, the critical issue among several challenges regarding the use of OER across all institutions is access to the internet (Wolfenden, et al., 2017). The lack of internet facilities has been identified as a problem that affects teachers' access and use of TESSA OER (Shayo & William, 2015). According to Wambugu and Karero (2015), many practicing teachers lacked the requisite ICT skills for accessing the TESSA OER even at the schools, which had computers and internet connectivity. The effectiveness of OER environments in an international setting is highly dependent on the capabilities and skills of the recipients (OCLOS, 2007). Teachers need to be able to access the TESSA OER from the TESSA portal without difficulty and to easily integrate the TESSA OERs into their lessons.

METHODOLOGY
The study employed the mixed method approach and used the sequential explanatory design to address the research questions. This study targeted Integrated science teachers in basic schools in the Effutu Municipality, in the Central Region of Ghana. The Municipality was selected for the study based on the fact that several workshops have been organized for over 30 JHS Integrated Science teachers to introduce the TESSA OER to them. The setting was purposively chosen based on the assumption that a good number of teachers might have taken part in these workshops and therefore may have had experience with TESSA OER. Census sampling technique was used to obtain the study sample, which was made up of 166 Integrated science teachers.

Both quantitative and qualitative data were collected for the study. The quantitative data was initially collected using a five-point Likkert scale questionnaire. In total, 166 questionnaires were distributed and 134 (80.7%) were successfully completed and returned. According to Baruch and Holtom (2008), the acceptable response rate in the social sciences surveys is 50% and above. Thus, the response rate of 80.7% (134) in this study was considered appropriate for data analysis.

The qualitative data was collected after the collection of the qualitative data using a semi-structured interview guide and document analysis. The selection of the respondents for the interview was based on the findings obtained from the questionnaire, which revealed two categories of teachers; users and non-users of TESSA OER. The users were teachers who

frequently used or have ever used TESSA OER in their classroom instruction and non-users were those who had never used TESSA OER in their classroom instructions. Eight of the users and seven non-users who were willing to participate in the interview were selected. The lesson notes of the eight users of TESSA OER were analysed immediately after the interview. A checklist was used to examine the lesson notes. The checklist contained items on the use of TESSA, which involved; the use of TESSA as reference material, as part of the lesson, and as a guide to teaching. The items under the use of TESSA OER were used to explore the topics teachers taught and the TESSA modules that were used in the lessons.

The data for this study were analysed using both quantitative and qualitative approaches. The quantitative data were analysed using SPSS version 20 and presented using descriptive statistics. The descriptive function of the SPSS was used to summarize, organize and reduce large data into interpretable forms. The results were used to describe the frequency of use of TESSA OER in their classroom instructions and the challenges the teachers face in using the TESSA OER.

The qualitative data collected through semi-structured interviews were analysed thematically. The audio-tape recording of each of the respondents was transcribed verbatim immediately after the interview was conducted. This ensured the credibility and accuracy of the data since relevant issues were assumed to be fresh on the researchers' mind (Merriam, 2009). The transcripts were read over severally and summarised under themes based on the areas covered by the interview guide. The themes were based on the checklists for the document analysis.

RESULTS AND DISCUSSION
The results of the study are presented in line with the research questions that the study sought to answer. Therefore**,** the results are presented under the following research questions:
1. **How did basic school Integrated Science teachers in Effutu Municipality use TESSA OER in their classroom instructions?**

The research question sought to find whether or not the basic school Integrated science teachers used TESSA OER during classroom instructions and how they used it. The frequency counts of the participants' responses of the items on the use of TESSA OER were converted into frequencies and percentages. The scale on respondents' use of TESSA OER was categorized as often, sometimes, rarely, and never. Based on this the participants were re-categorized as users and non-users to make discussion easy. The users were the respondents who had ever used TESSA OER in their teaching (included often, sometimes, and rarely categories). The non-users were those who had never used TESSA OER in their teachings. The descriptive statistics of respondents' use and awareness of the TESSA OER are presented in Table 1.

Table 1: Descriptive Statistics of Respondents' use and awareness the TESSA OER

Item	Category	Frequency	Percent (%)
	Often	20	14.9
	Sometimes	54	40.3
Teachers' Use of TESSA OERs	Rarely	42	31.3
	Never	18	13.4
	Total	**134**	**100.0**
	Workshop	38	28.4
How did you get to know about TESSA OER	Course of Study	22	16.4
	Friend	41	30.6
	Personal Search	33	24.6
	Total	**134**	**100.0**

The results indicated that few (14.9%) of the respondents have used TESSA OER in their classroom instructions as found in Table 1. This finding is in line with de Oliveira Neto et al's (2017) study, which pointed out that the use of OER is low in Sub-Saharan including Ghana. Again, this confirms Mishra and Singh's (2017) assertion that most teachers display a very positive attitude towards OER while being slightly less enthusiastic about using them.

Table 1 further explains how the respondents got to know about TESSA OER. Thirty-eight (28.4%) of the respondents indicated that they got to know about TESSA OER through workshops. However, the majority 41 (30.6%) indicated they got to know about TESSA OERs through friends whiles 22 (16.4%) of the respondents indicated that they studied TESSA as a course. The remaining 33 (24.6%) respondents testified that they got to know TESSA OER through personal search. This indicated that majority of the respondents were not officially introduced to TESSA OER as a course of study or through workshops, but rather got to know about TESSA through friends and personal search.

The Use Of TESSA OER In Lesson Plans
The teachers' use of TESSA OER was confirmed through the document analysis. The findings from the lesson notes analysed showed that the respondents who used the TESSA materials, used them as reference material. This confirms Wolfenden et al's. (2017) assertion that the common OER use evidence by individual educators is made visible through lesson plans. In this study, all the respondents (users) integrated the activities found in the TESSA science modules with other materials (such as the textbooks and the syllabus).

The practice of integrating activities found in the TEESA modules with other teaching resources is in line with Oates, Goger, Hashimi, and Farahmand (2017) findings that revealed that most teachers use OER to design their lesson plans effectively. This pattern is also similar to Adala's (2017) study, which revealed that some teachers use OER as a primary resource in their lesson plans while some teachers supplement and complement their lessons with other sources (textbooks), and even sometimes to the extent that they may not necessarily take a primary position. For instance, it was revealed in the document analysis that some teachers adapted the TESSA materials in writing their lesson notes. In first lesson notebook, the teacher selected some examples of activities she gave her JHS 1 pupils, from the TESSA Secondary Science OER, Module 3, Section 2, which was on the topic "measurement". Most of the content in this section

corresponded with Unit 3 of the Ghanaian JHS Science syllabus which was also on "Measurement". The examples included activities of using measuring equipment and questions adapted from the TESSA website.

In the second lesson notebook, the teacher also used an activity from case study 1 from the TESSA Secondary Science OER, Module 2 Section 5, which was named "States of matter". The module focused on the concept of solids, liquids and gases and the activity of think-pair-share was used in treating these concepts in the case study. Again, the concept of the state of matter was found in Unit 2 of the Ghanaian JHS Science syllabus.

In the third lesson notebook the teacher used an activity from the TESSA Science, Module 3 Section 1 which was named "Everyday Force-Investigating Movement". The module focused on the concept pulling and pushing of objects and the activity used was both 'finding forces and movement and learners pushing or objects found in classroom. The concept of force was also found in Section 5 Unit 1 of the Ghanaian primary four Integrated science syllabus. A further enquiry on the respondents' use of TESSA OER in the interview session revealed that some teachers use the TESSA OER because it complements their teaching, enhances their pupils' motivation and helps them to accomplish their teaching objectives. This is captured in the following excerpts:

Tr. 2: in fact, when I adopted the activities on the TESSA OER in my lessons,
the class became lively. The pupils learned with joy. The results of their assessment proved that they understood the concepts very well.
Tr. 8: I easily achieve my objectives when I use the TESSA OER. Once it is
learner-centered approach the pupils are engaged and I only have to serve as a facilitator to them.
Tr. 10: …the activities found on the TESSA OER give opportunities for the
pupils to exhibit their creativity and it makes teaching easy.

Also, results of the semi-structured interview data revealed that many respondents develop their teaching activity based on the learner-centered approach and therefore plan their lessons on activity-based methods. Most of them confirmed that the activities found on TESSA OER site are compatible with their teaching style. For example, when the respondents were asked whether or not the TESSA OER met their pedagogic needs, some gave the following responses:
Tr. 8: The most effective approach to teaching many of the topics in science is
the activity-based approach and that is what is found on the TESSA OER site.
Tr. 6: Oh yeah, the resources on the site meet my teaching pedagogy. I
particularly like the case studies. The case studies bring the activity into real life.
Tr. 1: Yes, the activities on the site meet my teaching pedagogy. It's a
well-constructed and resourceful website and the content is very good and easy for learners' engagement and understanding.

1. What Are Some Of The Challenges Basic School Integrated Science Teachers Face In Accessing And Using TESSA OER?

The research question 2 sought to find out the challenges that respondents face in accessing and using TESSA OER. The items on the challenges mainly focused on the access, the integration, and the use of the TESSA materials in respondents' classroom instructions. The questionnaire items were used to collect data on the challenges associated with the TESSA OER which was followed by the interview. The results of the questionnaire were analyzed using the frequency counts and percentages while the interview was analyzed thematically. The results revealed some challenges facing the respondents in accessing and using the TESSA OER. The main challenges include; the time-consuming nature of accessing TESSA OER; the

adoption of TESSA OER and the difficulty in summarizing and interpreting the TESSA materials into their lesson plans. Also, other challenges such as the lack of necessary computer hardware for accessing the OERs were identified. The challenges identified are presented in Table 2.

Table 2: Descriptive Statistics of Challenges Respondents faced in Accessing and Usin TESSA OER

Items	D	N	A	M	SD
Using TESSA OER is often frustrating	47 (35.1)	51 (38.1)	36 (26.8)	2.78	1.07
TESSA OER is time consuming	22 (16.4)	42 (31.3)	70 (52.2)	3.38	.94
Using TESSA OER in teaching activities is comm(in my school	19 (14.2)	31 (23.1)	84 (52.7)	3.53	.95
I have the necessary computer hardware for TESSA OER adoption	47 (35.0)	48 (35.8)	39 (29.1)	2.90	1.20
Technology associated with TESSA OER is easy	19 (32.2)	48 (35.8)	67 (50.0)	3.38	.92
I have a good internet connection for the access of TESSA OER	28 (20.9)	31 (23.1)	75 (55.9)	3.31	.98
Websites of TESSA OER is not user friendly	81 (60.3)	31 (23.1)	22 (16.4)	2.47	1.02
Current workload prevents me from accessing TESSA OER.	44 (32.9)	30 (22.4)	60 (44.8)	3.12	1.14
It is difficult for me to access TESSA OER for Teaching	56 (41.8)	28 (20.9)	50 (37.3)	2.96	.98
TESSA OER is less expensive	54 (40.3	37 (27.4	32.2	2.80	1.09
TESSA OER is compatible with the planning of my instructions	23 (17.1)	31 (23.1)	80 (59.7)	3.51	.95
I have permission (from your Head teacher, etc.) to use TESSA OER for teaching	57 (42.5)	38 (28.4)	39 (29.1)	2.79	1.02
I have inadequate knowledge for integrating TESSA OER in my lesson plan	15 (11.2)	47 (35.1	72 (53.7)	3.51	.89
I know how to search for and identify the suitable TESSA modules for my lessons	46 (34.3)	34 (25.4	54 (40.3)	3.00	1.20

Source: Field Data (2018)   Key: **D**=Disagree; **N**=Neutral; **A**=Agree

In Table 2, respondents' with mean scores below the average mean 3.0 were considered to have no problem using the TESSA OER whereas respondents with mean scores above the average mean 3.0 were considered to have problem using the TESSA OER. This is shown in Table 2.

However, the discussions were further explained using the frequency counts and the percentages in each of the succeeding sub-headings after the table.

Time Consuming Nature Of Accessing TESSA OER
On the issue of TESSA OER being time-consuming, although about 60% of the respondents indicated form the questionnaire data that the website of TESSA OER is user-friendly, a little above half of the respondents (52.2%) indicated that accessing the is TESSA OERs is time-consuming. This finding was further confirmed from the interview data that were collected. The respondents agreed that the TESSA OER improved their lessons, however, they indicated that a lot of time is required in accessing and adapting the TESSA OERs into their lessons. The following excerpts from the transcript of the teachers interviewed support this finding.
Tr. 4: The lessons in the TESSA OER require that one has to read, identify and structure the appropriate activities to fit in a particular lesson, and that requires a lot of time.
Tr. 11: The TESSA materials are good but time is my challenge.

This finding affirms Wiley and Hilton's (2009) assertion that the amount of time necessary to put OER in a format affects its use. This finding also confirms Peralta and Costa's (2007) study that revealed that lack of teachers' time to learn new skills were constraints to teachers' use of OER.

In addition, only a few (29.1%) of the respondents indicated that they have the necessary computer hardware for the access and adoption of TESSA OER. This study affirms Wambugu and Karero's (2015) study which revealed that many schools lack ICT infrastructure such as computers and power hence hinders teachers' access and use of TESSA materials.

Teachers' Inadequate Knowledge For Integrating TESSA OER In Their Lessons
A little above half (53.7%) of the respondents stated that they have inadequate knowledge for integrating TESSA OER in their lesson. They further explained that they found it somehow difficult to summarize and interpret the materials into their lesson plans. The following excerpts support this assertion:
Tr. 4: I have a problem with the aspect of assessment as learning, that part on the
site isn't clear to me.
Tr.3: The TESSA materials require one to read, identify and structure the appropriate activities to fit in a particular lesson, and that is not an easy thing to do all the time.
This finding on teachers inability to identify and structure appropriate activities from the TESSA OER and fit into their lessons contradicts the statement that teachers need to be able to access the TESSA OER from the TESSA portal without difficulty and to easily integrate the TESSA OER into their lessons (OCLOS, 2007). The discussions of the findings centered on the fact that few of the teachers often use TESSA OER in their classroom instructions. Their low use of the TESSA OER was basically influenced by some of the challenges facing their access and use of the TESSA materials.

CONCLUSION

The findings revealed that only a few of the basic school Integrated science teachers in the Effutu Municipality often use the TESSA materials in their classroom instructions. The seldom use of the TESSA materials is attributed to a number of challenges. Among the major challenges was the time consuming nature of accessing the TESSA OER units and inadequate knowledge on how to incorporate the TESSA innovation in their lesson plans.

RECOMMENDATIONS

It is therefore recommended that the TESSA team should keep organizing in-service training in the municipality to help improve the teachers' knowledge on how to incorporate the TESSA OER in their lessons and this will somehow reduce the time consuming nature of accessing the OER. Also, the TESSA team could design TESSA OER based on the structure of the local lesson plans of the partnering countries so that teachers can easily adapt them to suit the format of their lesson plans.

REFERENCES

Acquah, S. (2018) *The institutionalisation of Teacher Education in sub-Saharan Africa science -based open educational resources in a Ghanaian college of education*. A Ph.D thesis submitted to the University of Education, Winneba.

Acquah, S. (2015) *Interactive approach of introducing TESSA secondary science OER for extensive use: a focus on student teachers of UEW*. DETA Conference 2015 in Mauritius. [Accessed 16th March, 2017] Available from World Wide Web: http://www.tessafrica.net/sites/www.tessafrica.net/files/files/TESSA%20presentatios%20at%20DETA%202015_final.pdf.

Adala, A. (2017) *Assessing the impact of OER availability on the emergence of Open Educational Practices in Sub-Saharan Africa:* The case of an ICT-integrated multinational teacher education programme in mathematics and science. Unpublished ROER4D report to the International Development Research Centre.

Baruch, Y., & Holtom, B. C. (2008). *Survey response rate levels and trends in organizational research. Human Relations, 61*(8), 1139-1160.

Becta (2004). *A review of the research literature on barriers to the uptake of ICT by teachers.* Available from World Wide Web: https://www.becta.org.uk/page_documents/research/barriers.pdf

Boston Consulting Group (2013). *The Open Education Resources ecosystem*: An evaluation of the OER movement's current state and its progress toward mainstream adoption. Boston, MA: Boston Consulting Group. Available from World Wide Web: http://www.hewlett.org/sites/default/files/The%20Open%20Educational%20Resources%20Ecosystem_1.pdf

Cullen, J., Keraro, F.N., & Wamutitu, J. M. (2012). *Leadership support for school-based professional development for primary school teachers: The use of TESSA OERs in the* schools in Kenya. [Accessed 12th January, 2015] Available from World Wide: http://www.tessafrica.net/files/tessafrica/Cullen,%20Keraro%20and%20Wamutitu%20_2012

de Oliveira Neto, J. D., Pete, J., Daryono & Cartmill, T. (2017). *OER use in the Global South: A baseline survey of higher education instructors.* In C. Hodgkinson-Williams & P. B. Arinto (Eds.), Adoption and impact of OER in the Global South (pp. 69–118). Available from World Wide Web: https://doi.org/10.5281/zenodo.599535

Essuman S. (2015). *Using TESSA OERS to enrich the teaching and learning practices of basic school teachers.* DETA 2015 conference Mauritius institute of education 20th – 24th July 2015.

Harley, K. & Barasa, F. S. (2012). *Teacher education in sub-Saharan Africa: Formative evaluation*. [Accessed 17th August 2014] Available from World Wide: www.tessafrica.net/.../tessafrica/TESSA%20Summary(3).

Herrera, S. (2010). *Open Educational Resources*: How can open education programs be sustainable? Access to Knowledge, *2*(1), 1-11.

Hodgkinson-Williams, C. (2014). *Degrees of ease: Adoption of OER, open textbooks and MOOCs in the Global South*. Keynote address at the OER Asia Symposium, 24–27 June 2014. Penang, Malaysia. Retrieved from https://www.slideshare.net/ROER4D/hodgkinson- williams-2014-oer-asia.

Kanwar, A., Kodhandaraman, B. & Umar, A. (2010). *Toward sustainable Open Education Resources: A perspective from the Global South.* The American Journal of Distance Education, 24(2), 65–80. Available from World Wide Web: http://dx.doi.org/10.1080/08923641003696588

Kasinathan, G. & Ranganathan, R. (2017). *Teacher professional learning communities*: A collaborative OER adoption approach in Karnataka, India. In C. Hodgkinson-Williams & P. B. Arinto (Eds.), Adoption and impact of OER in the Global South (pp. 499–548). Available from World Wide Web: https://doi.org/10.5281/zenodo.601180

Kissinger, J. S. (2011). A collective case study of mobile E-book learning experiences. (Doctoral Dissertation). UNF Theses and Dissertations. paper127. Available from World Wide Web: http://digitalcommons.unf.edu/etd/127

Menon et al. (2017) *A study on the processes of OER integration for course development.* Unpublished ROER4D Report to the International Development Research Centre.

Merriam, S. (2009) *Qualitative research: A guide to design and implementation.* San Francisco, CA: Jossey-Bass.

Mishra, S. & Singh, A. (2017) *Higher education faculty attitude, motivation and perception of quality and barriers towards OER in India*. In C. Hodgkinson-Williams & P. B. Arinto (Eds.), Adoption and impact of OER in the Global South (pp. 425–458). Available from World Wide Web: https://doi. org/10.5281/zenodo.602784

Moon, B. Brown, S., & Ben-Peretz M., (2000) *The open learning environment*. Routledge International Companion to Education. London. Routledge.

Moon, R. & Wolfenden, F. (2007) *Open educational resources, international co-operation and teacher education in Sub-Saharan Africa*. In: *EADTU's 20th Anniversary Conference*, 8-9 Nov 2007, Lisbon, Portugal.

Moon, B., Leach, J. & Stevens, M. P. (2005). *Designing open and distance learning for teacher education in sub-Sahara Africa*: A toolkit for educators and planners. Harvard: Africa Region Human Development.

Morse, J. (1991). *Strategies for sampling*. In J. M. Morse (Ed.), *Qualitative nursing research: A contemporary dialogue* (pp. 127-146). Newbury Park, CA: Sage.

Ngman-Wara E. & Acquah S. (2015). *"Ghanaian junior high science teachers' reflections on the use of TESSA secondary science modules." American Journal of Educational Research*, 3 (3), 377-382.

Oates, L., Goger, L. K., Hashimi, J. & Farahmand, M. (2017). *An early stage impact study of localised OER in Afghanistan*. In C. Hodgkinson-Williams & P. B. Arinto (Eds.), Adoption and impact of OER in the Global South (pp. 549–573). Available from World Wide Web: https://doi. org/10.5281/zenodo.600441

OCLOS (2007). Open Educational Practices and Resources. OLCOS Roadmap 2012. Peralta, H. & Costa, F. A. (2007). Teacher's Competence and Confidence regarding the use of ICT. *Educational Science Journal,* 3, 75-84.

Rogers, E. M. (1995) *Diffusion of innovations* (4th ed.). New York: The Free Press.

Rogers, E. M. (2003). *Diffusion of innovations*, Fifth ed. New York: Free Press.

Stacey, P. (2007). *Open Educational Resources in a global context*. First Monday, 12(4). Available from World Wide Web: http://firstmonday.org/ojs/index.php/fm/article/view/1769/1649

Stutchbury, K. & Ngman-Wara, E. (2012). *Developing effective pedagogy: the thinking behind the TESSA secondary science project.* In: 56th ICET World Assembly: The Changing Global Perspective on the Role of Teacher and Teacher Education, 10-12 July 2012, Ghana.

UNESCO. (2012). *2012 World Open Educational Resources (OER) Congress*, 2012 Paris OER Declaration.http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/CI/CI/pdf/Events/Paris%20OER%20Declaration_01.pdf. Accessed 18/10/12

Wambugu P.W & Keraro F. N. (2015). *Improving the Learning of Science in Secondary Schools in Kenya Using TESSA Science OERs. Theme: Current methods of teaching: Prospects and challenges.* DETA 2015 Conference: Teacher Education and Development In Africa: The Need For Access, Equity, Sustainability, Quality And Relevance Within the Context Of Globalization. Available from World Wide Web: www.deta.up.ac.za

Wiley, D. & Hilton, J. (2009). *Openness, dynamic specialization, and the disaggregated future of higher education. IRRODL, 10*(5), 14. Athabasca University Press.