



Open Textbook Adoption: Implication for Chemistry Education in Nigerian Secondary Schools

Adoption de manuels scolaires ouverts : Implication pour l'enseignement de la chimie dans les écoles secondaires Nigérianes

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Abstract

This paper examines the implication of the use of open textbook for Chemistry Education in Nigerian secondary schools by reviewing different related articles to bring out the usefulness of Open textbook in teaching and learning of Chemistry. An open textbook is a free textbook that can be used freely by everyone. It is offered online by the author and has no copyright or Digital Rights Management (DRM) restrictions. Open textbook is accessible to all intended users. Both teachers and students, everybody is free to use it in different ways. The traditional print formats that have been in use for ages are facing the danger of extinction and the transition to digital textbook format is rapid. The advantages and challenges of adoption of open textbook were highlighted in this paper. From the review it was revealed that the use of open textbook in the education system improves teaching and learning significantly, have dependable quality and easy to use with reduced cost, as well as having the potential to increase the teacher's

opportunity to make input in the curriculum development. But the use is not without challenges. In open textbooks lack of quality and effectiveness is not ruled out. This notwithstanding, the adoption and use of open textbook is highly recommended by the researchers as an effective tool in Chemistry education in Nigerian secondary schools in anticipation that with time some of these challenges will be mitigated.

Keywords: Open Textbook, Traditional Print, Chemistry Education

Résumé

Cet article examine l'implication de l'utilisation de manuels ouverts pour l'enseignement de la chimie dans les écoles secondaires nigérianes en examinant différents articles connexes pour faire ressortir l'utilité des manuels ouverts dans l'enseignement et l'apprentissage de la chimie. Un manuel ouvert est un manuel gratuit qui peut être utilisé librement par tout le monde. Il est proposé en ligne par l'auteur et n'a aucune restriction de droit d'auteur ou de gestion des droits numériques (DRM). Le manuel ouvert est accessible à tous les utilisateurs visés. Enseignants et élèves, chacun est libre de l'utiliser de différentes manières. Les formats imprimés traditionnels qui ont été utilisés pendant des siècles sont menacés d'extinction et la transition vers le format manuel numérique est rapide. Les avantages et les défis de l'adoption de manuels ouverts ont été mis en évidence dans cet article. De l'examen, il a été révélé que l'utilisation de manuels ouverts dans le système éducatif améliore considérablement l'enseignement et l'apprentissage, a une qualité fiable et facile à utiliser avec un coût réduit, tout en ayant le potentiel d'augmenter la possibilité pour l'enseignant de contribuer au programme développement. Mais l'utilisation n'est pas sans défis. Dans les manuels ouverts, le manque de qualité et d'efficacité n'est pas exclu. Néanmoins, l'adoption et l'utilisation de manuels ouverts sont fortement recommandées par les chercheurs en tant qu'outil efficace dans l'enseignement de la chimie dans les écoles secondaires nigérianes en prévision qu'avec le temps, certains de ces défis seront atténués.

Mots-clés: manuel ouvert, imprimé traditionnel, chimie Éducation

Introduction

The place of Chemistry knowledge and skills in economic and

industrial development in the Nigerian society cannot be over emphasized, because Chemistry is all about utilization of natural resources for the development of mankind and the creation of artificial ones. The world is said to revolve around Chemistry. It is one of the major science subjects offered in Nigeria at the senior secondary school level, which offer a lot of occupational opportunities to people, but in spite of this, Chemistry education suffers a lot of setbacks, with fewer students enrolling into it after their secondary education. Reports from researchers indicate students' poor achievement in public examination, lack of interest, lack of evidence of skill acquisition showcased by inability of school leavers to transfer the knowledge acquired in Chemistry to their day to day life activities, (Ajewok, 2010; Udo et al, 2011; Igboegwu, 2011; Onah, et al, 2020). Students see it as a subject that is largely incomprehensible and abstract, and so, loose interest in it. A survey to find out why this is so, showed that Chemistry involves reasoning and problem solving which require both cognitive and technical skill. (Akins, 2013). Therefore, Chemistry unlike other subjects requires frequent reading and conceptualization, and so, needs a highly skilled set of teaching methods and teaching materials such as classroom technology materials and textbooks, good laboratory facilities, internet facilities, and other equipments. It not possible to master such a school subject without these facilities being in place even when there are competent teachers. Chemistry education involves teaching and learning of Chemistry concepts with adequate textbook facilities in a formal education setting by qualified teachers. Teachers must update their knowledge through the use of textbooks; students as well must have to increase their understanding with textbooks.

Notably, most good Chemistry textbooks are costly and unaffordable and sometimes unavailable to the students and teachers. This is an issue of great concern to Education stake holders because both the students and the teachers rely on textbooks as their major sources of information. When students cannot afford quality textbooks, they resort to such sources as summary notes by authors; some rely only on their teachers note and in this digital age, most rely on little bits of information from the internet which they find easy and affordable. The present national economic down turn, necessitates the upholding and adoption of any measure that will enhance students' and teachers' easy and cheaper access to quality learning materials such as open textbook.

Open textbook is the latest trend in textbooks. An open textbook is a free textbook that can be used freely by everyone. It is offered online by the author and has no copyright or DRM. Open textbook is accessible to all intended users. Both teachers and students, everybody is free to use it in different ways. Textbooks are generally reliable tools which provide creditable information that support and enhance students' understanding. This textbook format is an electronic one most adequately recommended and used at this digital age. They are available online for free. Open textbooks emerged out of the wider open educational resources (OER) movement, which seeks to offer educational materials that are free and open for use and reuse in teaching, learning and research (UNESCO, 2005). Open textbooks have no DRM and the content can be revised by the teacher, who can adjust, or modify the content to suit specific purposes and make the materials more relevant to the learners. This means the teacher can make it available in different formats. The teachers and students can pull together a number of ideas from different sources to create something new that can be freely shared with others. For example an open Chemistry textbook may be able to handle some difficult topics providing home works, quizzes, and tests and marking memos which students can download on their own, use at home and practice on their own or in the school with their teacher and then share among themselves.

Open textbooks are important to our education system not just because they have the potential to increase access to academic information due to reduced cost of books for students but also because they are created and shared for more people to have access to them. The teachers have the freedom to arrange the content to suit the students' need and environment. (Mason & Kimmonns, 2018). Open textbook is different from the traditionally-copyrighted materials, because there is no restriction to use and remix of information. The Commonwealth of Learning (COL) an international organization created by Commonwealth Heads of Government to promote the development and growth of open learning and distance education knowledge, resources and technologies in 2016 made available guides to developing open textbooks, so the transition from traditional bound copies of textbooks to the open educational resources is progressing rapidly in many countries of the world(Petride, et al, 2011), Nigeria should not be left

out, considering the enormous benefit of open education resource. Nigeria as a nation does not invest so much on the education sector; consequently, most Secondary school libraries are ill- equipped. Majority of the public schools do not have libraries at all. The current economic situation in Nigeria makes the situation and the purchase of textbooks more difficult for students and teachers. The remedy is to begin substituting the commercial textbooks print format with open educational resources (OER). The introduction of open textbook in Nigeria secondary schools Education system therefore becomes imperative with positive implications and it is therefore recommended. The recent outbreak of corona virus has even made the use of electronic means of teaching and learning more vital and relevant in the entire globe.

The place of Textbooks in Chemistry Education in Nigeria Secondary Schools

The place of textbooks in Chemistry Education in Nigeria Secondary Schools cannot be overemphasized. This is because textbooks have always been the primary educational resource, and is the pivotal instrument with which the Chemistry content can be learnt. Textbook is the core learning material, which is used by teachers and students to augment teaching and learning in order to bring about a specific set of educational outcome. Textbooks are very useful in Chemistry education especially because a greater part of what a learner needs to learn in Chemistry is rooted in the textbook. For teachers, it is a guide; for the students, it is a framework that helps them in organizing their learning both inside and outside the classroom. Chemistry involves reasoning and problem solving which require both cognitive and technical skills. The practical demonstrations and activities in Chemistry cannot be carried out in the absence of a textbook. Knight, (2015) noted that textbooks facilitate the development of cognitive skills, supports knowledge construction and information transfer. Chemistry which contains some concepts termed as abstract cannot be taught without a textbook with good content coverage, good illustrations and learning activities. This is because it is the main source of information for the teachers and students. At the end of a program, examinations and student assessments are derived heavily from textbooks. Odume (2014) shows also that, the reading of appropriate textbook enhances the knowledge of the subject matter and equally enhances the application of

such knowledge to problem solving, but found out that most of the Chemistry textbooks lacked detailed explanations, and there are no explanatory notes at the end of each topic.

In the light of the above, the adoption of open textbook format is very vital in Chemistry education in the Secondary Schools since the teacher as the instructor can modify the content in such a way as to provide a more detailed explanation, necessary diagrammatic expressions and other illustrations that will enhance the achievement of the lesson objectives. Although, there has been conflicting results on the advantages of Open textbook versus the traditional print format. Some report that there is no difference in cognitive learning among the students who use the different textbook formats but that students who chose e-textbooks for their education courses had significantly higher perceived affective learning and psychomotor learning than students who chose to use traditional print textbooks, while others report that, students comprehend information better in prints that were more than a page in length because of the disruptive effect of scrolling on comprehension.(Amanda, et al,2012). However, Open textbook appear to have greater outlined advantages; first is the issue of accessibility, secondly the availability and the affordability among others. Hence, Deok-Ho Jang¹, (2015) noted that digital textbooks can be used as an effective tool to increase student motivation, achievement and interest. In the light of the above, the adoption of open textbook in secondary school Chemistry education is quite appropriate to enhance the usefulness of textbook as a curriculum material.

Nigerian Secondary School Chemistry Curriculum and Chemistry Textbooks

To appreciate both the philosophy and the objectives of the Chemistry education and its development so far in Nigeria, it would be quite necessary to review some relevant portions of the National Policy on Education (NPE). The National Policy on Education stipulates that secondary education is expected to be a preparation for useful living within the society and also a preparation for higher education (FRN, 2004). To this end, one major objective of the Chemistry curriculum is to provide the students with basic knowledge in chemical concepts and principles through efficient selection of contents and sequencing, and to show Chemistry and its link with industry, everyday life, benefits and

hazards among others. Chemistry curricula commonly incorporate many abstract concepts which when not understood, further learning of Chemistry and other sciences will be compromised. Textbooks interpret the curriculum and transform it into concrete activities that teachers and students can carry out. Hence Katrin et al, (2018) describes a textbook as a mediator between the intended curriculum as official policy and the implemented curriculum by the teachers. The abstract nature of many Chemistry concepts, along with their content learning difficulties requires that Chemistry Education needs textbooks whose contents can be easily understood by students. Chemistry textbooks should be activity oriented, to reflect the newly transformed Chemistry curriculum. This will make the understanding of Chemistry contents easier for the learners. The way the content of the curriculum is presented to the students has a big role to play if the objectives of Chemistry education are to be fully achieved. The flexibility and the relationship between the textbook and curriculum content can go a long way to make this possible.

A Chemistry textbook can be flexible if it is in the open format. This means it is open to all whether you're the author, instructor or student; everybody is free to use materials in a variety of way without asking permission of the copyright holder. The content can be revised by the educator, can be adjusted or modified to suit specific purposes and make the materials more relevant to the students. For example, an open Chemistry textbook can handle some difficult topics. Providing home works, quizzes, and tests and marking memos which students can download on their own, use it at home and practice on their own or in school with their teacher. The teacher's note can equally be converted to open textbook and put online to help students who might have missed the lesson for one reason or the other. This makes the transition from traditional printed copy right formats to the open textbook formats expedient.

Significant Advantages of the Adoption of Open Textbooks in Chemistry Education in Nigeria Secondary Schools as Compared to Traditional (Physically) Bound Formats

Several scholars have pointed out the possibilities offered by open textbooks for effecting positive change on the students' learning. Literature reveals that in countries where it is already very much in use,

open textbooks and in general open education resource have the capability to improve learning outcomes in many areas. Hence, Deok-Ho Jang¹, (2015) noted that digital textbooks of which Open textbooks is one, can be used as an effective tool to increase student motivation, achievement and interest. The advantages Open textbooks have over the traditional print formats are apparent in a number of ways:

Enhancing Learner-Centered Teaching and Learning

Open textbook falls in line with more learner-centered, interactive and self-directed teaching models (Robinson, et al, 2014). In other words, Open textbooks provides opportunity for the teachers to be more proactive and for more learning to occur. The fact that, the traditional textbook formats reflect the values and methods of the author and rarely reflect the particular needs of different categories of learners, makes the adoption of Open textbook in teaching and learning of Chemistry contents fitting because the teacher has the freedom to reconstruct the content to meet the needs of the learner.

Flexibility of use by the teachers

Currently in Nigeria, the Chemistry curriculum which was revised in 2009 is activity packed and practical oriented; the use of open textbooks is expected to be more appropriate for the translation of this curriculum to reality in order to achieve the desired objectives of Chemistry education in Nigerian secondary schools. This is expected to be so because it permits the teacher to remix and re-use the contents to align with the way the topics are arranged in the curriculum. In which case the teacher as the leader of instruction can rearrange the content and introduce activities to suit the sequence in the curriculum according to the class and time. Since the culture and values of Nigeria nation vary from location to location, individual teachers can remix the content of a particular textbook to reflect the particular culture of that location so that learning can occur. Open textbooks format give teachers control and ownership of the lesson and empowers the teachers to reflect on how the materials could be redesigned and improved for better learning outcomes in contrast to the use of physical format.

Eradication of Book Piracy

One common feature of traditional textbook print publishing in Nigeria is the problem of book piracy..Book piracy is an illegal and illegitimate

reproduction of other people's intellectual property for economic gains without getting their approval or authorization (Nkiko, 2013). It is the biggest challenge facing the publishing industry in Nigeria and educational books are the worst hit (Ahmadu, 2017). This invariably, is due to the large number of consumers (students) that patronize educational books. The copyright policy attached to textbooks that are not open also makes textbook piracy a common occurrence. Book piracies, among other things discourage creativity among Nigerians. With the adoption and use of open textbooks, this problem will be on the way to being eradicated as there will be no need to pirate a book that is already open to all for use.

Opportunity for Textbook Revision

Traditionally (physically) bound textbooks are costly to revise and so, are rarely revised; they remain static and fixed for several years without being revised to new editions. In other words new trends and new discoveries in the ever changing scientific ideas are not reflected in good time thereby compromising the usefulness of the content. The fact that most traditionally(physically) bound Chemistry textbooks have the copy right restriction, there is no room for revising or redesigning of the textbooks contents and so, teachers and students use them as they are for many years without upgrading the contents. By this, teachers lack sense of ownership of the content they teach. They may not be satisfied with the way some concepts are presented in the recommended textbooks but do not have the freedom to redesign the content to suit the need of a particular class. The teacher is therefore restrained by the conventional copy right printed (physical) textbooks format in which case, the teacher is made to present the lessons to fall in line with the way the content is presented in the textbook. This has lead to the growing view that teachers lacked sufficient skills and content knowledge to successfully facilitate learning on their own. This view led to attempts to create instructional materials that were “teacher proof,” effectively cutting teachers out of the design process and relegating them to the role of implementers (Mason et al, 2018) Forcing teachers into using the textbooks as they are, makes teaching and learning an administrative affair, not an educative one. To confirm this, the content analysis of physically bound Chemistry textbooks currently in use in Nigeria Secondary Schools reveals that the contents of some Chemistry textbooks do not show they have been revised for many years, some contain inauthentic subject language and distorted content (Abonyi,

2011; Omebe, 2014).

Cost Effectiveness

In Nigeria, the increasing cost of commercial physically bound textbooks and decreasing financial support to public schools by the government makes many school and students not able to afford quality textbooks. A teacher can no longer assume that every student in the class has access to the recommended textbook, and it is impossible to master a subject such as Chemistry without a textbook. This fact makes the adoption of free on-line recourse such as open textbook in Chemistry education in Nigeria needful. To the best of the researchers' knowledge the use of Open textbook is not yet made popular in Nigeria Secondary Education system and so, majority are still stock with the old traditionally (physical) bound copies of Chemistry textbooks. The fact that most secondary schools in Nigeria do not have functional school library, those that have an existing Library are without adequate textbooks also makes the adoption of Open textbook vital.

Breaking Language Barrier in Chemistry

One major obstacle that has been faced by many students is the language of science, and the academic success of students in school subject is strongly tied to fluent use of subject language or vocabulary. (Ayodele, 2013). The language requires a careful and precise explanation in order to ensure that the meaning is conveyed. In the Nigerian context, Science and the language of Science are strange to the learners. The adoption of open textbook provides opportunity for the translation of Chemistry contents to alternative texts or language by the teacher therefore it will be a rewarding venture to adopt the use of Open textbook in Chemistry Education especially at the Secondary school level where the language of Science has been problematic, this will enhance understanding.

Regular Content Upgrade

The new and expanded topics that are added into the curriculum from time to time are not reflected in the old versions of physically bound format. Knowledge and understanding of concepts in Chemistry do change from time to time rendering old versions of textbooks inappropriate for use. With the adoption of Open textbook, any emerging Scientific discovery can be easily infused into the content of

the textbooks, unlike the traditionally (physically) bound format with the copyright restriction. The freedom offered by Open textbook takes care of outdated and wrong information dished out in textbooks by authors who probably may also have been battling with the understanding of some perceived abstract concepts in Chemistry but because of the quest for profit making; they go ahead and publish textbooks with outdated and distorted contents. With the Open textbook, more knowledgeable teacher can easily upgrade the content. Petrides et al, (2011) affirms that based on the freedom of use and revision, open textbooks prevent outdated information from being used in schools, and address the ability of the textbooks to provide current and relevant content to students. It is become therefore useful for Nigeria secondary schools to embrace this paradigm shift. Knight, (2015) suggested that since learning experiences are different from that of the days without technology, with constantly evolving technological tools and increase in digital curriculum materials, the shifting from traditional print materials to digital is appropriate for any Education system.

Perceived Challenges of the Adoption of Open Textbook for Secondary School Chemistry Education in Nigeria

Open textbook is highly recommended for the teaching and learning of Chemistry in Nigerian secondary schools considering the above advantages but this is not without some perceived challenges that must be dealt with for the teachers, students and the entire system to enjoy the maximum benefit from this technological development.

ICT Challenge

In Nigeria the challenge faced by this sector (information communication and technology) ICT is enormous. There are the issues of internet accessibility, network connection and compliance. Poor computer literacy on the part of the teachers and students is a major issue. Lack of ICT skilled instructors, inadequate ICT infrastructures, and unavailability of fund to the schools for the establishment of computer laboratories, power failures are all the setbacks to this move into using open textbook in educating people in Chemistry. The issues of textbook availability, accessibility, usability, content quality and readability are not left out. This notwithstanding, the use and adoption of open textbook is highly recommended as an effective tool in

Chemistry education in Nigerian secondary schools in anticipation that with time some of these challenges will be mitigated.

Usability Challenge

Another major challenge is the issue of usability. Usability refers to the ease of access and the use of website or information or product. A text book or a design is not usable if it does not fit into the context of the user or what the user wants to do with it. Usability in terms of a textbook therefore is the extent to which the book can be used by a specific user to achieve a specified goal, with effectiveness, efficiency and satisfaction. A usable text should be: easy for the user to become familiar with, easy for the user to recall the user interface and how to use it on subsequent visit, easy for user to achieve the objectives. It should be user friendly and should not be frustrating. In the Nigerian context this is a major challenge because many textbook writers are interested in their immediate gain not on the outcome of the textbook on the end users. To be able to curb this and use open textbook effectively in secondary school Chemistry education in Nigeria, this challenge must also be dealt with through the education of Chemistry textbook authors on the 17 usability factors which include: Efficiency, Effectiveness, Satisfaction, Learnability, Accessibility, Memorability, Ease of learning, Engagement, Navigation, Operability, Visibility, Convenience, Consistency, Completeness, because considering usability elements is one of the critical successful factors to ensure the digital textbook meets the user expectation.

Readability Challenge

Another very important challenge has to do with the readability of textbook, both physical and digital formats. Readability refers to the difficulty a reader of a certain level of reading skills may experience in going through and understanding a piece of written material. Readability is the ease with which a reader can understand a written text. Textbooks need to provide their readers with the ease of reading because it is only when one has successfully learnt to read a text that comprehension can take place. Providing students with texts that are accessible and matching to their reading abilities has always been a challenge for science educators. A poor comprehension of any Chemistry textbooks will automatically change the meaning of the concepts in the content and such results in frustration and much learning

will not occur, because active processing is unlikely to take place. The end result is poor performance and diminishing interest in the subject. With open textbook adoption, a Chemistry textbook that is not readable can be revised instantly to meet the reader's need without concern about the copy right ownership.

Conclusion

In conclusion, it is important to stay abreast of current developments in educational technologies; any adoption of technology to support instructional delivery must be well accepted and integrated into a solid plan of instruction. Given that Chemistry is seen as a difficult subject by many students, they should be encouraged to look for the most cost-effective means to source information that will bring the content to their level of understanding. This can be done when the use of open textbook is fully adopted and integrated into Chemistry education in Nigeria, because every teacher can revise the content and activities to reflect examples in the learners' environment without fear of Digital Right Management (DRM) restriction. A single student can download an open Chemistry textbook from multiple sources on-line and make it available to the rest of the class to photocopy and use at a reduced cost. This provides opportunity for best practices in teaching and learning. While the traditional (physically) printed bound text textbooks format may continue to be in use but gradually fading away, teachers and students need to begin to align with the use of open textbooks which gives access to wider range of information at a reduced cost.

Recommendations

Owing to the fact that teachers are expected to act as facilitators in collaborative learning environments using various textbooks, the researchers strongly recommend that:

- (1) The Nigeria government should introduce the use of open textbook in the secondary school Chemistry education system and provide a support system to that, financially and materially.
- (2) The Chemistry teachers should collaborate and covert their well written lesson notes into open textbooks and place online for everyone to access.

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