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Dear Author(s),

ACCEPTANCE OF ARTICLE FOR PUBLICATION

We write to inform you that your article entitled: **"CRITICAL ANALYSIS OF ANALOGIES RELATED TO EVOLUTION IN SELECTED BIOLOGY TEXTBOOKS USED IN NIGERIAN SECONDARY SCHOOLS"** has been accepted for publication in the Volume 2 Number 2 of the Al-Hikmah Journal of Education (AJE).

Please, accept our hearty congratulations.

Yours faithfully,

Dr. Olaolu P. Akinnubi
Managing Editor

CRITICAL ANALYSIS OF ANALOGIES RELATED TO EVOLUTION IN SELECTED BIOLOGY TEXTBOOKS USED IN NIGERIAN SECONDARY SCHOOLS

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ABSTRACT

The importance of the use of analogies in fostering better understanding of abstract scientific concepts cannot be over-emphasized in the field of science education. Textbooks like every other instructional material occupy a significant place in the teaching-learning process. This study was carried out to identify and analyze analogies related to evolution in selected Biology textbooks used in Nigerian secondary schools.

In this study, seven selected Biology textbooks are examined using descriptive analysis method to determine the types of analogies used in the textbooks. Analogies identified were classified in line with a classification scheme that was modified slightly from that of Rahmi and Pinar (2008). Criteria such as Representation format, Nature of Shared Attributes, Level of Enrichment, Description of Limitation, Use of the Term Analogy and Level of abstraction were examined. The identified analogies were subjected to validation by carrying out an inter-rater assessment. Five research questions were raised and answered. Data gathered were analyzed using frequency counts, percentages and Kappa to calculate the level of agreement between raters on the appropriateness and relevance of the analogies. Based on the analysis, a total number of 123 analogies related to evolution concept were identified in the seven Biology textbooks with an average of 17.57 per book. College Biology had the highest number of analogies (44), while Comprehensive had the least number (3). It was thereafter determined that these analogies were mainly Pictorial-verbal (63.41%), Structural (90.24%), Simple (94.31%) and Concrete-Concrete (89.43%). None of the authors describes the limitations of the analogies used or stated that they were using analogies. The appropriateness and relevancy of the identified analogies were also determined by subjecting the analogies to inter-rater reliability with a Kappa value of 0.634 and 0.701 respectively, which were substantial enough for the analogies to be valid. Based on the findings, the following recommendations were developed. Textbook authors should use analogies effectively in their texts either by using pictorial analogies which tends to arouse students' interest in sciences, since what is seen stick more to the memory than what is said or read. Authors should continue with the use of structural analogies since in Biology, it is essential to express traits, structures and behavior of biological phenomenon. The authors should however include more of enriched or extended analogies in their text, rather than simply using simple analogies. Authors could also precede the analogies with words like: analogous, analog etc. and also state the limitations of the analogies used since analogies are known to break down at a point and this will go a long way in preventing students' misconceptions.

Key Terms: Analogies, Biology, Evolution, Textbooks

INTRODUCTION

The field of education has undergone a significant shift in thinking about the nature of human learning and the conditions that best promote the varied dimensions of human learning. As in psychology, there has been a paradigm shift in designed instruction; from behaviorism to cognitivism and now to constructivism (Cooper, 1993).

Constructivism is based on the belief that learners keenly create, translate, and reorganize knowledge in individual ways (Mark, 2000). The idea here is that learners actively construct their understanding rather than passively absorbing or copying the understanding of others. Ulerick (2013) stated that the constructivist view of gaining information holds that learning is a process of

connecting new knowledge to existing knowledge, involving active engagement of the learner's mind.

As Duit, Roth, Komorek and Wilbers (2001) noted "Analogical reasoning is an essential feature of learning process from the constructivist perspective which postulates that every learning process include a search for similarities between what is already known and the new" (p. 285). The theory of constructivism is attributed to Bruner (1960) and Piaget (1980) who articulated that knowledge is internalized by learners through the processes of accommodation and assimilation. Thus, when individuals assimilate, they can incorporate new experiences into an already existing framework. One of the ways, students' prior knowledge could be tested is by introducing such students to analogical reasoning.

According to Piaget's model, real learning can be achieved only after crossing several internal hurdles. First, the mind must filter and sort through extraneous stimuli. If the mind of the learner is not engaged in what is to be learnt, such encounter will not bring about effective learning. Good analogies begin by bringing learners into the realm of attention by relating new learning features to the learners' experience or bridging the gap between what is known and what is yet unknown. Thus, constructivism provides the best explanation for the way an analogy generates meaning during analogical learning. Because of the importance attributed to analogies in fostering effective learning, analogies are not only used in the classroom settings but are also included in textbooks.

There is no doubt that some aspects of science courses contain many concepts perceived by students as difficult. In Biology for instance, it has long been noted that concepts of ecology, evolution and genetics include many aspects that students perceived as difficult and the list of ideas has continue to grow (Okebukola & Jegede, 1989). In agreement with this assertion, (Abimbola, 1998; Olorundare & Oni, 2007) listed some concepts and issues in Biology such as evolution, cellular respiration, nervous coordination, chromosome the basis of heredity as parts of relevant and challenging topics. One way of making these abstract but important difficult concepts understandable to students is by teaching with analogies.

Biology can sometimes be difficult particularly when describing things that are abstract or concepts that may not be fully comprehended at the first instance (Chew, 2004). Some of the ideas perceived difficult by students as reported by Oyedokun (2002) and corroborated by West African Examinations Council (WAEC) Chief Examiners Report (2006) include genetics, evolution, ecology, physiology among others. Various research findings have shown that a number of concepts in Biology that include evolution, contain topics that pose difficulty for Biology students to understand (Esiobu & Soyibo,1995; Okebukola,1995). Also, Sorantopoulos and Tsaparlis (2002) and Chew (2004) reported that students have the notion that evolution concepts in Biology are boring and require only memorization to get one through. Quite a number of students find evolution concepts irrelevant, while others find them incredibly technical with complicated terms littering every sentence in a typical Biology text (Jiya, 2011).Thus, Usman (2008) as cited in Jiya (2011) observed that many students have a wrong perception about evolution concepts on the basis of how they were taught Biology in schools. One of the learners factor which affect meaningful learning in Biology is the wrong conception of concepts held by the students (Salin & Ozakaya, 2003; Sani, 2006). The wrong conception according to Akinsola and Igwe (2002) could be attributed to the inability of the teachers to put across scientific ideas clearly to students or as a result of poor reference materials like science textbooks.

Textbooks play a significant and largely unexamined role in science education, particularly at introductory levels in college and high school.Textbooks support teachers by aiding day-to-day

planning and teaching, and long-term professional development. Despite the improvement observed in technology and communication, textbooks still holds a dominating place in importance and unparalleled place of importance influencing the content of what is the target in our schools(Olorundare, 2014; Yener,2012). Throughout the educational process, science textbooks are one of the most commonly used teaching materials, which the students and teachers trust and both rely on as a reference material they could consult to upgrade their knowledge (Lumpe & Scharmann, 1991). Biology text materials; like other textbooks have been seen as veritable tool in the teaching of students (Backer, 2004) as cited in Ayodele (2013). Several studies have shown that these textbooks are often too difficult for students (Backer, 2004; Ayodele, 2009; and Ayodele, 2012) most especially for those who learn science in a second language.Therefore, analyzing the Biology textbooks used by students and teachers will contribute to the literature on science education. One area of concern that need analyzes in science textbooks is the way that analogies are structured and used by the authors.

When educational analogies are used in texts, some of them may not be suitable for all learners and hence could bring about misconceptions. An analogy is an explanation that compares a fact that is unidentifiable and unfamiliar with another one identifiable and familiar. The strange fact is the target while the familiar fact is the analogue. Analogy is one of the most important tools used to hasten perceptual change in scientific learning, and to stimulate teaching and learning characterized by scientific reasoning and inventions (Duit, 1991). Abimbola (2001), refers to analogies as pictorial, metaphorical, or model method of thinking that suggest areas of similarities between two or more things that requires observation and/or experimentation to be empirically established.

Many literature on textual analogies have shown that: (1) the majority of the textbook analog/ target pairs share similar behaviors or relationships as opposed to just sharing same peripheral features: (2) majority of the analogies are explained to some extent, although they are seldom explained entirely: (3) analogies are usually communicated in textual format, although Biology and social science textbooks contain more pictorial representations of analogies than chemistry textbooks: (4) statement of the limitations of the analogies used are often not stated and (5) analogies are unequivocally identified as analogies only about 15% of the time (Curtis & Reigeluth.1984; Curtis, 1988; Thiele & Treagust. 1994.1995) as cited in Orgill and Bodner (2006).

Thiele and Treagust (1992; 1991) in their study concluded that: (1) some authors assumed classroom teachers would effectively use the analogies, despite no evidence that teachers have pedagogical content knowledge in this area; (2) the frequency of analogy inclusion implies an unwillingness by authors to use analogies in textbook situations; (3) the authors are unfamiliar with research guides regarding analogy presentation results; (4) only 4.3% of the textbooks stated the limitations of the analogies used; and, (5) only 21% of the analogies presented included any statement identifying the strategy as an analogy. Jeongho, Soonhwa and Taehee (2003) worked on Chemistry textbooks and found out that few analogies included description about limitations of the analogies and that the seventh editions of the textbooks included more analogies than the sixth edition. Orgill and Bordner (2006) in their study observed that most authors do not present analogies in the most efficient manner since none of the analogies are thoroughly explained. Onasanya (2013) found out that the textbooks used in Nigeria secondary schools contained varying numbers but similar types of analogies.

Because of the importance attributed to evolution as a unifying science concept and because of the perceived difficulties held by both the teachers and students, this study tends to do a content analysis of some selected Biology textbooks used in Nigerian secondary schools.

Purpose of the Study

This study focuses on identifying and analyzing analogies related to evolution in some selected Biology textbooks used in Nigerian Senior Secondary schools. Specifically, the study intends to

1. Analyze by classifying the analogies identified in the selected Biology textbooks
2. Assess the relevance of the analogies used to evolution.
3. Assess if the analogies identified are appropriately used.

Research Questions

In this study, answers were sought to the following research questions:

1. What types of analogies are used in the selected Biology textbooks to explain evolution?
2. Are the analogies in the selected Biology textbooks relevant to evolution?
3. Are the analogies identified in the selected Biology textbooks appropriately used?

Method

This is descriptive research that involves screening the contents of the selected Biology textbooks as it relates to evolution. Seven textbooks which are in conformity with the present curriculum of the country and are also recommended by some of the examinations bodies and Kwara State Ministry of Education and Human Capital Development were examined. Details of the books is as highlighted in table 1

Table 1

List of Selected Biology Textbooks Used in Nigerian Senior Secondary Schools

s/no	Code	Name of textbook	Authors	Publishers	Place of publication and year
1	Book A	STAN Biology for senior secondary schools 3	Science Teachers Association of Nigeria	HEBN Publishers Plc	Ibadan(Nigeria)/ 2012
2	Book B	Modern biology for Senior secondary schools	Ramanligam, S. T.	Africana First Publishers Plc	Onitsha (Nigeria)/ 2013
3	Book C	College Biology	Idodo-Umeh, G	Idodo Umeh Publishers	Benin City (Nigeria), 2011
4	Book D	Essential biology for senior secondary schools	Michael, M. C.	Tonad Publishers Ltd	Ibafo (Nigeria), 2012
5	Book E	Comprehensive certificate Biology for	Ambuno, S., Egunyomi, A.,	University Press Plc	Ibadan (Nigeria), 2010

		senior secondary schools	& Osakwe, V. C.		
6	Book F	New Biology for senior secondary schools (New ed.)	Stone, R. H., Cozens, A. B., & Ndu, F. O. C.	Learn Africa Plc	Lagos (Nigeria). 2014
7	Book G	Senior secondary Biology 3 (3rd ed.)	Ndu, F. O. C., Asun, p., Aina, J. O.	Learn Africa Plc	Lagos (Nigeria), 2013

Each book that was used in this content analysis was read thrice by the researchers. Every figure and statement considered to be an analogy were marked, photocopied and passed on to each other for further scrutiny. After which the identified analogies were classified into the different categories using a classification scheme originally designed by Thiele and Treagust (1994) with slight modifications from those of Pinar and Rahmi (2008). The analogies in the selected Biology textbooks were classified using the categorization highlighted in Table 2

Table 2
Framework for categorization of the analogies

Criteria	Types of analogies	Description
Nature of shared attributes	Structural	Shares only structural attributes like shapes, size etc
	Functional	Shares on functional attributes like behavior
	Structural/Functional	Shares both structural and functional attributes
Representation	Verbal	Uses verbal context only in the analog domain
	Pictorial-Verbal	Uses both verbal and pictorial context in the analog domain
Level of enrichment	Simple	Uses statements 'like', 'mimics' etc with no further explanation between the analog and target
	Enriched	Indicates some statement of shared attributes
	Extended	Made up of a combination of simple and enriched analogies and used overtime in the text
Abstraction	Concrete ----- Concrete	Both analog and target are concrete
	Abstract ------ Abstract	Both analog and target are abstract
	Abstract ------ Concrete	Target is abstract and analog is concrete

Criteria	Types of analogies	Description
Use of term 'analogy'	Used	Included terms like 'analogy', analogous etc
	Not used	Does not include the terms; 'analogical', 'analogy' etc
Description of limitation	Described	Include some statements highlighting the unshared attributes
	Not described	Does not include any statement of the unshared attributes

Sulaiman (2015)

A pro forma of the identified analogies was prepared and given to an expert in the field of science education and natural science to determine the relevancy (i.e if the analogies are relevant) and appropriateness of the analogies identified.

Data Collection and Analysis

Data collected were analogies that are related to the concept of evolution in selected Biology textbooks used in Nigerian secondary schools. The data collected for this study were analyzed using frequency counts and percentages for research question 1 and Kappa for research questions 2 and 3.

Research Question 1: What types of analogies are used in the selected Biology textbooks to explain evolution?

From the analysis of the selected Biology textbooks, a total number of 123 analogies related to evolution concepts were identified. An average of 17.57 analogies was found in each textbook. It was however seen that Comprehensive had the fewest number of analogies (3), and the most (44) were in College Biology.

In terms of mode of representation, it was identified that pictorial-verbal analogies (63.41%) and verbal analogies (36.59%) were most commonly used in the biology textbooks used in Nigerian secondary schools (Table 3). In terms of nature of shared attributes of analogies in the sampled textbooks, it was discovered that most of the analogies used were structural analogies (90.24%) whereby the analog and the target only shared structural attributes, functional analogies were 7.32% and structural-functional analogies was 2.44% (Table 3).

However, based on the level of enrichment, the authors were observed to make use mostly of simple analogies (94.31%), and enriched analogies (5.69%). An example of simple analogy use of in the textbook is that "the stick insects looks like a dead twig" while that of enriched analogy is one in which evolution was described as a tree whereby the stem represents the older form, while the branches represents the modern form. None of the textbook made use of any statement that neither illustrate the limitations of the analogies nor preceded the analogies with words like; analogous, analogy etc. (Table 3). However, in terms of level of abstraction, it was observed that (89.43%) concrete-concrete, (4.07%) abstract-abstract and (6.50%) abstract-concrete analogies were most commonly used in explaining the concept of evolution which covers adaptation in the selected Biology textbooks used in Nigerian secondary schools.

Table 3
Categorization and Number of Analogies in Biology Textbooks Used in Nigerian Secondary Schools

Category	ANALOGIES	Book A	Book B	Book C	Book D	Book E	Book F	Book G	Total	%
NUMBERS		12	17	44	14	3	11	22	123	100
Presentation Format	Verbal	5	11	11	4	1	2	11	45	36.59
	Pictorial-Verbal	7	6	33	10	2	9	11	78	63.41
Analogical Relationship	Structural	12	11	43	13	3	10	19	111	90.24
	Functional	-	4	-	1	-	1	3	9	7.32
	Structural - functional	-	2	1	-	-	-	-	3	2.44
Level of Enrichment	Simple	11	17	41	13	3	10	21	116	94.31
	Enriched	1	-	3	1	-	1	1	7	5.69
	Extended	-	-	-	-	-	-	-	-	-
Limitation	Existing	-	-	-	-	-	-	-	-	-
	None	12	17	44	14	3	11-	22	123	100
Use of the term Analogy, analogous etc	Used	-	-	-	-	-	-	-	-	-
	Not Used	12	17	44	14	3	11	22	123	100
Level of Abstraction	Concrete — Concrete	10	14	42	13	3	10	18	110	89.43
	Abstract – Abstract	-	3	-	1	-	-	1	5	4.07
	Abstract – Concrete	2	-	2	-	-	1	3	8	6.50

Source: Sulaiman(2015)

Research Question 2: Are the analogies used in the Biology textbooks appropriately used?

Table 4a shows the cross tabulation of the raters, while the analysis on Table 4b shows that the inter-rater reliability for the raters was Kappa= 0.644 ($p < 0.0001$), 95% CI. This result shows

that there is a substantial agreement between the raters as to the appropriate use of the analogies in the sampled textbooks.

Table 4a

*Rater1*Rater2 Cross Tabulation Used in Determining the Appropriateness of the Identified Analogies*

		Rater 2		Total
		1.00	2.00	
Rater 1	1.00	100	5	105
	2.00	6	12	18
Total		106	17	123

Table 4b

Interrater Reliability Index for the Degree of Appropriateness of the Identified Analogies

	Value	Asymp. Std. Error[a]	Approx. T[b]	Approx Sig.
Measure of Agreement Kappa	0.634	0.101	7.031	.000
No Of Valid Cases	123			

a. Not assuming the null hypothesis
b. Using the asymptonic standard error assuming the null hypothesis

Research Question 3: are the analogies in the selected Biology textbooks relevant to evolution?

Table 5a shows the cross tabulations of the raters while analysis on Table 5b shows that the inter-rater reliability for the raters was Kappa= 0.701 ($p < 0.0001$), 95% CI. This result shows that there is a substantial agreement between the raters as to the relevance of the analogies identified in the sampled textbooks used in Nigerian secondary schools.

Table 5a
*Rater1*Rater2 Cross Tabulation Used in Determining the Relevance of the Identified Analogies*

		Rater 2		Total
		1.00	2.00	
	1.00	109	2	111
Rater 1	2.00	4	8	12
Total		113	10	123

Table 5b
Inter-rater Reliability Index for Determining the Relevance of the Identified Analogies

	Value	Asymp. Std. Error[a]	Approx. T[b]	Approx Sig.
Measure of Agreement Kappa	0.701	0.115	7.810	.000
N Of Valid Cases	123			

Summary of Major Findings

The results presented in this chapter, indicate the following significant findings

1. All the selected Biology textbooks used for the research contained varying numbers of analogies which are similar in some instances.
2. Based on the nature of shared attributes, 90.24% of the analogies identified were structural analogies, while 7.32% of the analogies were functional analogies and 2.44% were structural-functional analogies.
3. Based on the level of representations, 63.41% of the analogies identified were pictorial-verbal while verbal analogies accounted for 36.59%
4. Based on the level of enrichment, 94.31% of the analogies identified were simple analogies while enriched analogies accounted for 5.69%.
5. College Biology has the highest percentage (35.77%) of identified analogies, followed by Sen. Sec. Bio. 3 (17.89%), Modern Bio. (13.82%), Essential (11.38%), STAN 3 (9.76%), New Bio. (8.94%), and, Comprehensive (2.44%)
6. None of the textbooks stated the limitation of the analogies used which may be a pointer to the fact that the authors do not know that analogies can be a double edged sword which can evoke better understanding of concepts as well as lead to misconceptions when not used appropriately. This also shows that the authors might not be aware of the fact that analogies breakdown at some point in time hence their refusal to state limitations for the analogies.
7. None of the textbooks also indicated that they made use of analogies which may mean that the authors did not use analogies consciously.

8. Based on level of abstraction, (89.43%) concrete-concrete, (4.07%) abstract-abstract, and (6.50%) abstract-concrete analogies were identified in the selected Biology textbooks used in Nigerian secondary schools
9. The analogies identified were substantially relevant to evolution since they could help bridge the gap between known and unknown concepts.
10. The analogies identified were appropriately used.

Discussion

The finding of this study revealed that all the selected Biology textbooks contained analogies although at varying numbers. College Biology had the highest number of identified analogies (44), followed by Sen. Sec. Bio. 3 (22), Modern Biology (17), Essential (14), STAN 3 (12), New Biology (11) and, Comprehensive had 3, with an average of 17.57 analogies per book. This shows that authors of textbooks trust the power of analogies in bringing about better learning. This finding is in line with those of Onasanya (2013) who stated that Biology textbooks used in Nigerian secondary schools contains varying numbers but similar types of analogies

The finding showed that, based on nature of shared attributes 90.24% of the analogies identified were structural analogies. The authors might have decided to use structural analogies because Biology tends to deal with more concrete objects than physics and chemistry. This finding is in line with those of Dikmenli (2010) who stated that most of the analogies in biology textbooks were configured primarily as structural analogies. This however is in contrast to the findings of Jeongho et al (2004) who stated that most of the analogies identified were mainly functional analogies in their analysis of chemistry textbooks.

The finding showed that, based on the level of representation 63.41% of the analogies identified were pictorial-verbal analogies. This might be due to fact that the authors are of the opinion that what the students visualizes sticks to the memory more than words spoken or written down. Such a finding is in line with that of Orgill and Bodner (2006) who stated that analogies are usually represented in textual format, although Biology and social science textbooks contain more pictorial representations of analogies than chemistry textbooks. This however is also in contrast with the findings of Dikmenli (2010) who found out that most of the analogies identified were mostly verbal analogies. However, by using pictorial-verbal analogies, the authors are able to use illustrations to bridge the gap between the analogue and target. Hence students can transfer the image in the textbooks to real life situations.

The finding showed that based on level of enrichment, 94.31% of the analogies were simple analogies. By including simple analogies in the textbooks the authors may be underestimating the difficulties that students could encounter when attempting analogical transfer. It might also be due to the fact that the authors do not actually know they are using analogies or are not familiar with the fact that analogies could also evoke misunderstanding especially when it is not used in an effective manner. This is in line with the findings of Curtis and Reigeluth (1984), Dikmenli (2010) who stated that the most common type of analogy used in science textbooks are the simple analogy. Thus, it is worthwhile to include more of extended and enriched analogies in science textbooks since these two often explain the relationships that exist between the analogue and the target and also reduces the level of misconception learners might have.

The major finding showed that College Biology had the highest number of identified analogies (35.77%) followed by Sen. Sec. Bio. 3 (17.849%), Modern Bio (13.82%), Essential (11.38%), STAN 3 (9.76%), New Bio (8.94%), and Comprehensive (2.44%). The high numbers

of analogies in some of the text might be as a result of the location of the publishers. For example, the publishers of senior secondary Biology 3 were initially foreigners (Longman Publishers) while the author of Modern Biology is also a foreigner. Although College Biology's author and publisher are not foreigners, but the author is an experienced teacher with two major doctorate degrees. It can thus be deduced that these authors have adequate knowledge about analogies and hence employ it more in explaining abstract concepts than the local authors.

The finding showed that none of the textbooks states the limitation of the analogies used. By not stating the limitations of the analogies used, the authors might not have had adequate knowledge about the use of analogies. They might also be underestimating the difficulty that students will encounter when attempting analogical transfer between the analogue and target. This is in line with the findings of Dikmenli (2010) and Jeongho et al. (2004) who found out that extremely few analogies included description of limitations of the analogies. By not including the limitations, students might end up taking the analogy for the real concepts and this can bring about misinterpretation or misunderstanding among the learners.

None of the sampled Biology textbooks also made mention of the term analogy in their textbooks. Not prefixing the analogies with the term 'analogy', 'analogous' can lead to students learning the wrong concepts since the learners might perceive the idea wrongly. This might be as a result of the fact that the authors might not have had adequate knowledge about analogies or used the analogies unconsciously without actually knowing they are using it. This is in line with the assumption and findings of Jeongo et al (2004) and Orgill and Bodner (2006) who stated that the term analogy were rarely mentioned as analogies and are explicitly identified as analogies only about 15% of the time. This showed that the authors of the textbooks might be taking analogies to be the same thing as simple illustrations.

The finding also showed that based on level of abstraction, 89.43% of the analogies were concrete-concrete. This shows that authors of the textbooks are concerned with the cognitive level of the learners whom they might have believed needed an alternate conception of idea to get show scientific facts right. This findings is in line with those of Newton (2003) who posited that, the concrete-concrete analogy type was used more often (59.8%) in science textbooks written for the 7-11 age-group students of elementary schools in the United Kingdom. This however is in contrast with the findings of, Orgill and Bodner, 2006; Yener, 2012, who observed that majority of the analogy based on level of abstraction were concrete-abstract. Since the major goal of analogy is to make abstract objects concrete for the students to visualize.

. The findings of the study also revealed that the analogies were appropriately used in explaining the concept of evolution in the selected textbooks. This shows that the authors are aware of the powers of analogies in fostering understanding of abstract or difficult biology concepts. This is in line with the findings of Thiele (1991) who was of the opinion that those authors employing analogies more frequently in their texts tends to see analogies more as a motivational tool.

Conclusions

Based on the preceding findings and discussion, the following conclusions were made. The study showed that Biology textbook authors are familiar with analogies and also employ analogies in explaining abstract science concepts. The outcome of this research further showed that the textbook authors mainly made use of Structural, Pictorial-verbal, Simple and concrete-concrete analogies in presenting the concept of evolution in the selected Biology textbooks.

None of the authors however stated the limitations of the analogies used or precede the analogies with any statement indicating that it was an analogy.

From the analysis, College Biology had the highest number of identified analogies i.e. 44, which represents 35.77%, while Comprehensive Certificate had the least number of analogies, 3 (2.44%). It is thus concluded that textbooks with high numbers of analogies should be recommended to students because it can further enhance their understanding of abstract science concepts. The implication of this finding is that students can readily contact their textbooks in order to gain better knowledge about abstract science concepts when the teachers are not around to explain such difficult concepts.

Recommendations

Based on the prevailing findings and their discussions, the following recommendations are suggested:

1. Textbooks authors should use analogies effectively in their text as this will go a long way in explaining abstract concepts and make science more meaningful to the students. The authors should write the textbooks in such a way that the abstract science concepts can easily be comprehended by the students even when the teachers are not around to explain such abstract science concepts.
2. The authors should continue with the use of structural analogies since in Biology, it is essential to express the traits, structure and behavior of a biological phenomenon before looking towards the mechanistic explanations of how it works.
3. The authors should continue with the inclusion of pictorial-verbal analogies in the Biology textbooks as it helps students develop mental image of the target concept. Most often, what students visualize sticks to their memory more than words written down especially for students learning science through a secondary language like English
4. The authors should include more of enriched or extended analogies rather than using simple analogies since simple analogies does not fully establish the relationship that exists between the analogue and the target. By including enriched or extended analogies, the relationship that exist between the analog and target are fully explained and this will go a long way in fostering better understanding of abstract concepts.
5. Authors should endeavour to state limitations of analogies used as this will go a long way in preventing misconception or alternate conception by the students, since analogies are better explained as double edged sword which could either increase or hinder students' performance.
6. Wherever analogy is used in the textbook, authors should identified such as analogies by using words like; 'analogical', 'analogous' etc so that the students will not assume that the analogical statement is the actual phenomenon they intend to learn.
7. Analogies are most important when students have no idea of the new concept to be discussed, hence it is recommended that the authors should use more of abstract-concrete analogies rather than the concrete-concrete analogies since the students are already in secondary schools and not primary schools.

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