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Students' perceptions on the difficulty of biochemistry concepts covered in Rwandan secondary school biology curriculum

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Abstract

This study explored the Rwandan secondary students' opinions on learning biochemistry concepts covered in the Rwandan advanced level of secondary school biology curriculum, and the reasons behind the difficulty of the concepts. In this research, sequential exploratory mixed-method designs were adopted. The sample comprised 195 secondary school students, who were purposively selected from the schools in Rwamagana and Kayonza districts of Rwandan Eastern Province. Data were collected using self-administered questionnaires and focus group semi-structured interview guides. Data analysis was carried out using both quantitative and qualitative approaches. Results from this research showed that photosynthesis and respiration are the major units that are challenging to study with the respective percentages of 62.5 and 75.1. On the other hand, the concept of enzymes is the most difficult according to students' views. The lack of adequate laboratory and learning resources and teachers' teaching styles were reportedly the reasons behind the difficulty of these units. Therefore, the provision of continuous professional development training on advances in teaching and learning biochemistry to in-service teachers would be one of the strategies to enhance students' understanding of these concepts.

Keywords: Biochemistry, photosynthesis, enzymes, respiration, secondary school students.

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1. Introduction

Biochemistry is a branch of biology that seeks to understand how various lifeless biomolecules give rise to the properties of living organisms (Nelson & Cox, 2004). Biochemistry has evolved as a distinct scientific discipline via combination of biology with organic, inorganic and physical chemistry. Initially, it started from studying how living things obtain energy from food, the chemical basis of heredity, what fundamental chemical changes occur in disease pathogenesis and related issues. Biochemistry has been instrumental to the rise of scientific disciplines such as molecular biology, neurochemistry, bioinorganic, bioorganic and biophysical chemistry. This growth has influenced recent biotechnological advances that have greatly affected human life, such as the discovery of new drugs, medical diagnostics, disease-resistant crops and many more. It is foretold that this influence will continue to develop in the future (American Chemical Society, 2015; Tibell & Rundgren, 2009).

Naturally, learning and teaching biochemistry, regardless of the level of education, has been relatively thought to be difficult due to numerous complicated vocabularies and abstract concepts. Additionally, it is viewed as a set of an unlimited number of biochemical molecules, pathways and reactions which are mostly learned through memorisation, making biochemistry hard and confusing to most students (Afshar & Han, 2014; Lau, 2018; Pillai Nair et al., 2013). Teaching biochemistry in secondary schools is challenging since it is not usually taught as a separate subject, meaning that some biochemistry concepts are covered in biology or even in chemistry subjects (Cid et al., 2004). Indeed, it has been documented that, in most secondary schools, teachers focus mainly on classical concepts, such as the Krebs cycle and the Calvin cycle, while in the laboratory they stick to demonstrations, such as the testing of biomolecules from food samples. This may result in the missing of breakthroughs in the field causing a gap between what is being practiced by scientists and what is thought in high schools and universities. Consequently, students fail to appreciate the revolutionary change taking place in biology and, therefore, they get less impressed with biochemistry and biology in general (Cid et al., 2004; Huang, 2000).

The difficulties of students in learning biology have been heavily scrutinised by researchers and educators. For instance, numerous biology concepts have been reportedly to be difficult by secondary school students. Among them include but are not limited to water transport in plants, respiration and photosynthesis, protein synthesis, cell division, physiological processes, genetics, and genetic engineering (Anderson et al., 1990; Bahar et al., 1999; Finley et al., 1982; Johnstone & Mahmoud, 1980; Lazarowitz & Penso, 1992; Seymour & Longdon, 1991; Tolman, 1982; Tekkaya et al., 2001). It is believed that students' difficulties in grasping biology concepts affect negatively student's motivation and academic achievement (Özcan, 2003). These difficulties have attracted researchers to understand why students struggle with learning many biology concepts. The reasons behind these difficulties include the heavy biology curricula in schools, teaching methods, abstract and interdisciplinary nature of most biology concepts, difficulties with the textbooks and lack of adequate instructional resources and laboratory materials are the other factors preventing students from effectively learning biological concepts.

Although researches were extensively carried out on students' difficulties in learning biology as a whole subject, there is a need of understanding the student's views on studying a specific field of biology, such as biochemistry. Even if biochemistry seems to be inexistent in most secondary school curricula, some fundamental elements of biochemistry are thought in secondary school. It is believed that the grasp of such fundamental concepts at the secondary level will prepare students to undertake biochemistry-related courses at the university level. Therefore, knowing how students feel about

studying such biochemistry concepts at the secondary school level would help curricula developers, teachers and teacher training programmes to plan for effective teaching activities that can help students learn biology better and have more positive attitudes towards biology and other sciences as well (Çakıroglu et al., 2003; Çimer, 2012; Telli et al., 2009).

It is in this perspective that this study was conceived to explore the students' perceptions and the reasons behind the difficulty of the biochemistry concepts in Rwanda secondary schools' biology at the advanced level. This study will provide a knowledge base for curricula developers and biology teachers in the implementation of the new competence-based curriculum which have been used since 2015 in Rwanda. From students' perspective, knowing the factors affecting their learning would suggest the areas of improvement as far as the teaching and learning biochemistry concepts are concerned. Additionally, teachers can see their weak and strong areas regarding teaching biology in general and biochemistry as a specialised field of biology.

1.1. Theoretical framework

To explore the students' perceptions about learning biochemistry, this research is anchored from the theory of cognitive constructivism. According to the theory, the knowledge is constructed by students through hands-on-minds-on practice. The theory states that knowledge is not transferred, rather it is created by the learners during the learning process (Akerson et al., 2000). Therefore, conceptual misunderstanding or alternative conceptions which a student might have about a term may be deterrent to further learning. The personal constructs theory also served the purpose of this research. According to this theory, a person develops his own constructs on how the world works and, in turn, these constructs are used to make sense by personal observation and experience. Based on their observations and experiences when learning a concept, a student personally develops constructs about the concept learned. These constructs are mental representations which learners use to interpret the learned concepts.

According to both theories, it is evident that learning is centred on the learners. Learners' previous knowledge plays a role in their learning. Furthermore, learners develop personal constructs about their learning. Learners then use these constructs to make sense of their observations and experiences about learning. Therefore, the theories fit better in this research since it aims at exploring students' views about their learning based on their observations and experience in learning biochemistry concepts investigated in this study.

From these theoretical perspectives, the following research questions were framed to guide this study:

1. What are the perceptions of secondary school students about the difficulty of biochemistry topics covered in A-level biology curriculum?
2. Under the biochemistry topics presented, what are the concepts most difficult to study from secondary school students' perspectives?
3. What are the reasons behind the difficulties of learning biochemistry concepts?

2. Methods

2.1. Study design and approach

The study was carried out using both quantitative and qualitative research approaches, following a sequential explanatory design. It is believed that the combination of methods from both approaches

would generate complementary results that would add greater breadth and depth to the analysis than either one could generate on its own (Creswell, 2007; Creswell, 2012; Creswell & Plano Clark, 2011; Warfa, 2016; Zohrabi, 2013). In this research, the biochemistry concepts difficult to study were studied using the quantitative research approach followed by a qualitative study of the reasons why identified difficult concepts are hard.

2.2. Research Participants

The research participants were purposively selected from secondary school students in Rwamagana and Kayonza districts of Eastern Province, Rwanda. They were 195 students in senior 6 classes at six different secondary schools.

2.3. Data collection tools

Data were collected from two phases. In the first phase, a self-administered questionnaire developed by the researcher was used for to collect quantitative data. The questionnaire comprised closed-ended questions which were on a 7-points Likert scale. The development of the questionnaire was based on the Rwandan advanced level secondary school curriculum. The Rwandan secondary school biology curriculum is subdivided into topic areas, which also are subdivided into sub-topic areas, and the sub-topic areas are made up of units (REB, 2015). To construct the questionnaire, the units related to biochemistry were identified from the Rwanda Education Board (REB) curriculum by biochemistry experts, and in each unit, biochemistry concepts were revealed. The questionnaire comprised three parts: the first part covers the demographics of the respondents; the second part covers the biochemistry units; and the third covers the concepts in each unit. The content validity of the questionnaire was determined by subjecting the instrument to biochemistry experts, while the internal reliability was determined by the calculation of Cronbach's alpha, which was 0.6. It is argued that alpha values above 0.6 are acceptable (van Griethuijsen et al., 2014)

2.4. Data Collection Process

The questionnaire was administered to students, after being explained the purpose of the study, and ensured that the confidentiality of their responses will be strictly observed. After exploring the biochemistry concepts difficult to study, the preliminary analysis of results revealed that photosynthesis and respiration were the difficult concepts. Therefore, the second phase of data collection was arranged to explore the reasons why these concepts are hard. The data collection was carried out using focus group interviews guided by a semi-structured interview guides made up of open-ended questions.

2.5. Data analysis

Data analysis was carried out both qualitatively and quantitatively. Descriptive statistics were used to determine the frequencies of difficult biochemistry topics and concepts as perceived by secondary school students. To analyse the interview data, all answers were transcribed and this was followed by their analysis. This analysis was carried out by categorising answers into four categories, namely nature of the concept, teachers' teaching style, students' learning habit, students' feelings and attitude towards the topics and learning environment. In each category of answers, the similarity of the responses was checked and the frequency of the similarity was estimated.

3. Results

3.1. Topics which are difficult to study according to students' views

Students were asked to rate according to the difficulties of the given biochemistry topics based on their experience while first studied it. Table 1 shows the results of this study.

Table 1. Topics which are difficult to study according to students' views

	Frequency and Percentage (%)						
	Entirely difficult	mostly difficult	somewhat difficult	neither difficult nor easy	somewhat easy	mostly easy	entirely difficult
Biological molecules	12 (6.2)	23(11.8)	17(8.7)	46(23.6)	60(30.8)	9(4.6)	28(14.4)
Nucleic Acids	25(12.8)	24(12.3)	67(34.4)	17(8.7)	15(7.7)	8(4.1)	39(20.0)
Photosynthesis	72(36.9)	38(19.5)	12(6.2)	6(3.1)	30(15.4)	27(13.8)	10(5.1)
Cell Respiration	63(32.3)	42(21.5)	24(12.3)	21(10.8)	14(7.7)	15(7.7)	16(8.2)
Homeostasis	6(3.1)	16(8.2)	17(8.7)	16(8.2)	33(16.9)	90(46.2)	17(8.7)

According to the findings presented in Table 1, respiration was the topic perceived to be most difficult. 129 (75.1%) students perceived respiration to be difficult to study. Photosynthesis, on the other hand, was the second difficult topic according to the students' views. 72 students perceived it to be entirely difficult, 38 students thought that photosynthesis is mostly difficult, whereas 12 students perceived it to be somewhat difficult, i.e., 122 (62.5%) students perceived that photosynthesis is the most difficult biochemistry topic they learned. Nucleic acids were also rated as one the topics that is difficult to study: 12.8% of the students perceived that nucleic acids are entirely difficult to study, while 12.3% felt that nucleic acids are mostly difficult and 34.4% thought that nucleic acids are somewhat difficult, i.e., 59.5% of the students perceived nucleic acids to be difficult. Biological molecules and homeostasis were perceived to be easy to study. For instance, 49.8% of the students felt that the biological molecule unit was easy, while 23.6% felt that biological molecules are neither difficult nor easy to study. On the other hand, 73.6% of the students, in total, perceived that homeostasis is not difficult.

3.2. Biochemistry concepts most difficult to study from secondary school students' perceptions

Among the Topics presented in Table 1, a list of concepts in each topic was given to students and they were requested to rate their difficulties based on their experience faced while studying them. Table 2 shows for the findings of this research.

Table 2. concepts difficult to study according to study views

biological molecules	Frequency and Percentage (%)						
	Entirely difficult	mostly difficult	somewhat difficult	neither difficult nor easy	somewhat easy	mostly easy	entirely difficult
water	6(3.1)	8(4.1)	7(3.6)	16(8.2)	8(4.1)	39(20.0)	111(56.9)
carbohydrates	10(5.1)	12(6.2)	64(32.8)	17(8.7)	37(19.0)	42(21.5)	13(6.7)
proteins	27(13.8)	23(11.8)	16(8.2)	38(19.5)	42(21.5)	39(20.0)	10(5.1)

lipids	18(9.2)	32(16.4)	26(13.3)	54(27.7)	29(14.9)	18(9.2)	18(9.2)
testing of biological molecules	58(29.7)	50(25.6)	20(10.3)	27(13.8)	19(9.7)	21(10.8)	0(0)
enzymes	62(31.8)	44(22.6)	36(18.5)	7(3.6)	22(11.3)	9(4.6)	15(7.7)
Vitamins and minerals	33(16.9)	46(23.6)	40(20.5)	23(11.8)	29(14.9)	16(8.2)	8(4.1)
Nucleic acids							
DNA structure	52(26.7)	74(37.9)	36(18.5)	23(11.8)	3(1.5)	3(1.5)	4(2.1)
RNA structure	51(26.2)	35(17.9)	61(31.3)	32(16.4)	5(2.6)	5(2.6)	6(3.1)
Difference between RNA and DNA	25(12.8)	30(15.4)	29(14.9)	89(45.6)	6(3.1)	6(3.1)	10(5.1)
Biological Roles of DNA and RNA	42(21.5)	28(14.4)	92(47.2)	5(2.6)	5(2.6)	11(6.2)	12(5.6)
Photosynthesis							
structure of Chloroplast and light harvesting system	74(37.9)	26(13.3)	28(14.4)	54(27.7)	4(2.1)	4(2.1)	5(2.6)
Light-dependent reactions	29(14.9)	48(24.6)	66(33.8)	43(22.1)	1(.5)	5(2.6)	3(1.5)
Light-independent reactions	32(16.4)	66(33.8)	38(19.5)	47(24.1)	2(1.0)	5(2.6)	5(2.6)
other carbon fixation pathways (C4 and CAM)	52(26.7)	49(25.1)	49(25.1)	40(20.5)	1(.5)	2(1.0)	2(1.0)
Homeostasis							
Regulation of blood glucose	50(25.6)	49(25.1)	42(21.5)	40(20.5)	4(2.1)	6(3.1)	4(2.1)
Regulation of blood pH	39(20.0)	42(21.5)	34(17.4)	43(22.1)	13(6.7)	15(7.7)	9(4.6)
Regulation of blood water and ions	35(17.9)	26(13.3)	51(26.2)	41(21.0)	4(2.1)	12(6.2)	26(13.3)
Urea formation	21(10.8)	9(4.6)	28(14.4)	23(11.8)	28(14.4)	31(15.9)	55(28.2)
Respiration							
Structure of ATP	22(11.3)	22(11.3)	20(10.3)	20(10.3)	37(19.0)	54(27.7)	20(10.3)
Glycolysis reactions	34(17.4)	38(19.5)	32(16.4)	19(9.7)	27(13.8)	33(16.9)	12(6.2)
Link reactions	24(12.3)	40(20.5)	52(26.7)	58(29.7)	17(8.7)	4(2.1)	0(0)
Krebs cycle	16(8.2)	42(21.5)	51(26.2)	41(21.0)	25(12.8)	7(3.6)	13(6.7)
Oxidative phosphorylation	62(31.8)	27(13.8)	15(7.7)	40(20.5)	25(12.8)	17(8.7)	9(4.6)
Anaerobic Reactions	26(13.3)	34(17.4)	23(11.8)	7(3.6)	53(27.2)	52(26.7)	0(0)

From Table 2, on the side of biological molecules, the concept of enzymes was the most difficult concept according to students' views. 62 students perceived that the concept of enzymes is entirely difficult; 44 students thought that the concept of enzyme is mostly difficult; and 36 students perceived that the concept of enzymes is somewhat difficult, i.e., 142 students perceived that the concept of enzymes is difficult to study. The concept of testing of biological molecules was the second difficult topic to study according to students' perceptions, where a total of 128 (65.5%) students perceived that testing of biological molecules is harder to study. Water, on the other hand, was the easiest concept to study according to students' views, i.e., 158 (81%) students said that water is easy to study.

On the side of nucleic acids, the DNA structure and biological functions of both DNA and RNA were the most difficult concepts where 162 (83.1%) students perceived that these concepts are hard. The RNA structure was also among the difficult concepts where 147 (75.4%) students thought that the RNA structure is difficult to study. The difference between DNA and RNA seemed not to be as difficult as the previous topics.

Photosynthesis and its components was perceived by the students as one of the most difficult units to study. A total of 128 students reported the concept of chloroplast structure and photosystems, while a total of 143 students perceived that the concept of light-dependent reactions is difficult and 136 students reported that light-independent reactions are difficult. 159 students viewed other carbon fixation pathways' (C4 and CAM) and concept to be difficult.

On the homeostasis side, students perceived that the regulation of glucose is the most difficult concept to study where 72.2% perceived that the regulation of glucose is a difficult concept to study,

while 55.9% thought that the regulation of blood pH is difficult and 57.4% perceived that the regulation of blood, water and ions concept is difficult. 58.6% believed that urea formation is easy to study.

Respiration, unlike photosynthesis, and all its components seemed not to be equally difficult. For instance, the link reactions and Krebs cycle were the most hard to study, where, respectively, 62.4% and 55.9% of the students shared the same views, and 53.3% of the students perceived that oxidative phosphorylation is difficult and the easiest concept was the structure of ATP.

3.3. Reasons why photosynthesis and respiration are difficult and students' feelings about studying them

According to the data presented in Table 1, respiration and photosynthesis are the topics perceived to be very difficult to study. Students were interviewed to identify the reasons behind the difficulty of the topics and their feelings when it comes to studying them either in self-studies or anywhere they encounter them.

Regarding why respiration and photosynthesis are difficult, the answers provided by the students to this question ranged from the nature of the concept, teachers teaching styles, students' learning habit, students' feelings and attitude towards the topics, and to the learning environment, most of them, however, shared the idea that the topics are naturally complex which make them difficult.

On the teachers' side, students said that some teachers are not teaching well because they skip them, while others get stacked with time and consequently students fail to understand the concept thought. On the students' side, some students felt that their attitude in searching other resources can help them understand better, but failing to do so, results in a misunderstanding of the topic, while others believe that lacking real-life connection of the topics results in being difficult to study. Lastly, with regard to the learning environment, students said that the lack of resources, such as simulations, audio-video materials and other state-of-the-art technological tools, is the major factor making the learning of these concepts tough, whereas other students felt that the lack of laboratory practicals also plays a role in making respiration and photosynthesis hard to study.

Regarding how students feel when they encounter these topics in their studies, students mostly said that they get bored and uninterested in them. Others reported that the topics are scary and annoying. However, other students said that it makes them happy to study them, while some felt that the difficulty of topics made them feel like they are not good enough to understand them, hence decreasing their confidence and self-esteem. On the other hand, some feel that even if the topics are difficult, it is their responsibility to work hard to understand them. Table 3 summarises the students' answers to this question.

Table 3 Reasons why photosynthesis and respiration are difficult

Category	**Students' Answers**	**Frequency of similarity**
nature of the concept,		
	The topic is naturally complex	56
	the topic is new	5
	set of complex biochemical reactions	13
	the topics are very big and tiresome to study	26
	Total	**100**
teachers teaching styles		

	The teaching methods of the teachers (teachers do not explain well)	57
	teachers' lack of time to explain deeply	14
	Low teachers' content knowledge	11
	Total	**82**
Students' learning habit		
	the topics do not make sense to students	10
	Students' learning habits	5
	Lack of a real-life connection	9
	The negative attitude of students	5
	Total	**29**
Students' feelings and attitude towards the topics		
	Feeling bored and uninteresting	97
	The topic is scaring	2
	It feels good and happy to study it	29
	Must work hard to try to understand it	32
	Decrease one's confidence and self-esteem	8
	It feels annoying and unhappy to study it	9
	Total	**177**
learning environment		
	Few or lack of laboratory practices	39
	the topic is more theoretical	17
	lack of learning facilities includes video tutorials	20
	Total	**76**

4. Discussion

Biochemistry, being naturally a visual subject, requires students to develop an understanding of numerous representations (Linenberger & Bretz, 2014). Although there exists researches on students' understanding of some of the biochemistry concepts, there is still a need to understand how secondary school students view these concepts.

The study's findings showed that respiration was the topic perceived to be most difficult; link reactions and Krebs cycle were also the concepts most difficult to study, while the structure of ATP was the easiest concept. Similarly, Çimer (2012) reported that aerobic respiration was among the five most difficult biology topics to study. It has been reported that cellular respiration and metabolism are concepts which are poorly understood by students and perceived to be difficult by many teachers as well (Songer & Mintzes, 1994). Furthermore, Galvin and Mooney Simmie (2015) reiterated that photosynthesis and respiration are the most prevalent topics that secondary school students find conceptually challenging, and they reported that both pre-service teachers and students showed unacceptably high levels of misconceptions. These misconceptions are one of the causes of the difficulties reported by the students. Therefore, there is a need to implement a conceptual change to eliminate these difficulties.

Photosynthesis, on the other hand, was the second topic most difficult according to the secondary school students' views. The interdisciplinary nature of this topic poses a challenge to students to grasp the concept. This is due to the fact that the topic deals with numerous concepts, such as the physics of light, chemical reactions, enzymes, membranes and energy relationships (Panijpan, 2008). The

connection of all those concepts may cause students confusion and misconceptions, leading to the difficulty of the topic. Russell et al. (2004) added that the challenges in photosynthesis education are the conceptual difficulty of the topic and the microscopic and abstract nature of the processes which make it difficult to picture, in addition to the technical difficulties with experimentally demonstrating photosynthesis. To tackle these issues, researchers have been trying to use computer simulations and animations, which showed improvements in students' understanding of the concept of photosynthesis (Çepni et al., 2006; Hamzat et al., 2017; Handan Güne et al., 2011; Russell et al., 2004). Therefore, to make learning photosynthesis easy to learn, educators have to take into consideration the use of such technology tools during the learning and teaching processes.

Nucleic acids were also rated as one the topics difficult to study, with the structure and biological functions of both DNA and RNA being the most difficult concepts. Similarly, it was reported that students struggle to understand genetic concepts, such as DNA, gene and chromosomes (Lewis & Wood-Robinson, 2000; Saka et al., 2006; Shaw et al., 2008). It has shown that basic concepts, such as nucleotide, gene and DNA, are topics in which students find misconceptions (Langheinrich & Bogner, 2015), and these misconceptions affect students' learning, hence cause difficulties in understanding the concept (Hasenekoglu & Timucin, 2007). Failure to understand the structure and biological functions of DNA may result in students struggle to grasp the concepts of genetics and molecular biology.

Biological molecules were perceived to be easy to study. However, the concept of enzymes and the testing of biological molecules were perceived to be difficult to study. The concept of enzymes is reportedly to be difficult and includes abstract concepts (Kurt, 2013), explaining the reason why students find enzymes difficult to study. The abstract nature of the enzyme concept may result in confusion and misconceptions. In their study, Linenberger and Bretz (2014) showed that students held several misconceptions in the understanding of how enzymes interact with their substrates. These interactions are the basis of biochemistry, no wonder why students are first introduced to this concept at the secondary level (Linenberger & Bretz, 2014). Therefore, proper understanding of how enzymes function is critical to understanding more biochemistry topics. Enzyme–substrate interaction is related to many biochemistry ideas, such as the Krebs cycle, metabolism and DNA synthesis, to name a few (Humphreys, 2015). Regarding biological molecules, students perceived it to be easy to understand. It was found that students were familiar with terms like 'protein', 'carbohydrate' and 'fat' because they may draw this knowledge from sources like health courses and exposure to public media (Bledsoe, 2013). Although students are familiar with these terms, it was found that some may have little knowledge of the classification of biological molecules. Hence, the difficulty in testing biological molecules once again appears, as reported here in this article.

Photosynthesis and respiration were reportedly the most difficult biochemistry concepts to grasp. Students reported many factors which they think make these concepts difficult to study. Those factors may be grouped into the nature of the topics, teachers' teaching methods and learning environment. Photosynthesis and respiration, like other biochemistry concepts, are viewed as a set of a large number of biochemical molecules, pathways and reactions that are not easy to distinguish and are mostly learned through memorisation (Afshar & Han, 2014; Pillai Nair et al., 2013). Consequently, this causes the loss of interest in biochemical sciences by the students. Apart from these concepts being naturally complex, the lack of connectivity of these concepts with real-life poses a challenge for students to study them. As far as the student is concerned, scientific models may seem like a story and have nothing to do with 'real life' (Bledsoe, 2013) for proper learning to occur, students should transfer what they learned. Therefore, failure to see the connectivity of what is being learned with real life may be a contributing factor to the difficulties in learning.

Findings from this study revealed that teachers' teaching methods are contributing factors to students' difficulties in learning biochemistry concepts. Students reported that teachers focus on the theoretical part of the lesson with less focus on the practical aspect of the lesson. Similar results were reported by Çimer (2012), where the researcher found that biology lessons were carried out through teachers' lectures with mere use of practical works and other student-centred activities in biology classes. This implies that biology teachers focus on only talking and transferring theoretical or abstract knowledge without even providing real-life examples. Furthermore, it was reported by the students in this research that some biology teachers' teaching methods and their misunderstanding of the topic play another role in making them difficult, and sometimes they may skip them. Akçay (2017) similarly observed a weakness in the understanding of energy flow and matter, cycling and cellular respiration concepts by prospective elementary science teachers. Conceptual misunderstanding of the teachers and their teaching styles can affect students' understanding of the content being learned. It is believed that the teachers, being the focal points of all teaching and learning, should be pedagogically competent and knowledgeable in order to properly impart the knowledge they give to their students. Therefore, the varying teaching styles and techniques by teachers would cause no boredom to the students in the classroom, since employing several styles, the teachers encourage students to become self-motivated independent learners (Barberos et al., n.d.).

5. Conclusion

Biochemistry is the backbone of modern biological sciences. Although it is a discipline, biochemistry is not thought of in secondary school curricula; however, some of its concepts are thought in biology in the secondary school curricula. This study explored the secondary school students' experience with learning biochemistry concepts presented in the Rwanda advanced level secondary school curriculum. Using mixed-methods sequential explanatory designs, data were collected and analysed quantitatively and qualitatively. Results from these findings revealed that photosynthesis and respiration were perceived to be difficult to study. A similar finding is not far from what is reported in the literature where the two concepts are reportedly to be conceptually challenging which might be the source of the difficulty in learning photosynthesis and respiration. Among the reasons why the two concepts are difficult to study include but are not limited to the concepts themselves where students perceived that they are naturally complex biochemical reactions, teaching methods of the teachers (teachers do not explain well) and lack of laboratory practical. According to the literature, these reasons are cosmopolitan, especially in the developing world.

6. Recommendations

Based on these findings, it would be better if pre-service programmes prepare biology teachers to use a variety of teaching styles and resources to enhance students' learning. For in-service teachers, provision of a continuous professional development course should be available to acquaint them with the current advances in the field of biological science as well as incorporate modern state-of-the-art technological tools to enhance students' learning specifically when it is perceived that no adequate resources are available. Lastly, further researches are needed to understand the secondary schools' pre-service and in-service teachers' technological and pedagogical content knowledge of these concepts. Furthermore, a research is needed to understand how Rwanda secondary school students view their biology learning environment.

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