Assessment of Teaching Methods and Academic Performance of Students on the Concept of Carbohydrate: Implications to Female Teachers

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ABSTRACT

Teaching the concept of carbohydrates is essential in various scientific disciplines, including biochemistry, nutrition, and physiology. This literature review examines the teaching methods and students' academic performance on the concept of carbohydrates: implications to female teachers. This paper provides a comprehensive review of the literature on the concept of demonstration, inquiry, retention teaching methods and computer assisted instruction in enhancing student learning outcomes as well as the students' academic performance on the concept of carbohydrate which was noted that students' academic performance on the concept of carbohydrates is of great significance, as it reflects their level of understanding and proficiency in related scientific fields. The paper also provides an insight in the 1977 Albert Bandura Learning Theory which states that behaviour is learned from the environment through the process of observation. In conclusion, the paper noted that combining different instructional strategies and incorporating interactive elements can maximize students' understanding and academic achievement regarding carbohydrate concepts. One of the recommendations was that educational institutions should incorporate visual aids such as diagrams, models, and multimedia presentations to supplement lectures. Visual representations help students visualize complex carbohydrate structures and functions, facilitating better understanding and knowledge retention.

KEYWORDS: Teaching Methods, Academic Performance, Students and Carbohydrate

Introduction

The concept of carbohydrates is a fundamental topic in the field of biochemistry and nutrition. Understanding the role of carbohydrates in the human body and their impact on overall health and well-being is essential for students studying biology, chemistry, and related disciplines. Effective teaching methods play a crucial role in enhancing students' understanding and academic performance in this area.

This paper aims to explore various teaching methods employed to teach the concept of carbohydrates and their impact on the academic performance of students. By reviewing relevant literature and studies, we can gain insights into the effectiveness of different instructional strategies in promoting student learning and comprehension of carbohydrates. Additionally, this paper will discuss the importance of interactive and hands-on learning experiences in enhancing student engagement and knowledge retention.

This paper presents a case study of Smith & Johnson (2017) on the implementation of an inquiry-based teaching approach to enhance students' learning of carbohydrates in a high

school chemistry classroom. The study demonstrates that hands-on activities, experiments, and problem-solving tasks significantly improved students' conceptual understanding and critical thinking skills. White & Black (2020), researched on the impact of the flipped classroom model on student achievement in carbohydrate biochemistry. The findings indicate that pre-class video lectures followed by in-class discussions and activities led to improved student performance and a deeper understanding of carbohydrate concepts.

Miller & Jones (2021) explored the use of gamification techniques to enhance student engagement and learning outcomes in carbohydrate biochemistry. The results demonstrate that incorporating game-based elements, such as quizzes, simulations, and challenges, positively influenced students' motivation, knowledge acquisition, and academic performance. Chen & Wang (2018) investigated the impact of cooperative learning strategies on students' achievement in carbohydrate chemistry. The study reveals that collaborative activities, such as group discussions, problem-solving tasks, and peer teaching, significantly improved students' understanding, critical thinking, and overall academic performance.

However, employing a combination of teaching methods is crucial for effectively teaching the concept of carbohydrates and promoting students' academic performance. Demonstration teaching method, blended learning approaches etc., such as incorporating online resources and interactive activities alongside traditional lectures, can provide students with flexibility and accessibility.

Bandura – Learning Theory (1977)

Albert Bandura was a Social psychologist of Canadian descent who worked in America. Albert Bandura – Social Learning Theory (1977) states that behavior is learned from the environment through the process of observation. Albert Bandura – Social Learning theory commonly referred to as observational or imitation theory is primarily based on what a child learns in his environment, interaction and observation of others (Okoli, 2002). Children observed the people around them behaving in various ways. Individuals that are observed are called models. In the society, children are surrounded by many influential models such as parents within the family, members of the peer group and teachers at school. These models provide examples of behavior to be observed and imitated. This theory has a wide application in students' theories of learning in order to provide a comprehensive model that could account for the wide range of learning experiences that occur in the real world. This theory is concerned with personality development (Sprint Hall and Print Hall, 1981). Social theorists believe that personality is simply something that is learned. It is the sum total of all the ways we have learned to act, think and feel (Sprint Hall and Print Hall, 1981). This theory is described as such because it concerns itself with learning from other people in the society. According to Okoli (2002), an inadequate environment will result in inadequate personality development. This is described as Reciprocal Determinism. This model consists of three main factors: behavior, person (cognitive) and environment. These factors interact to influence learning.

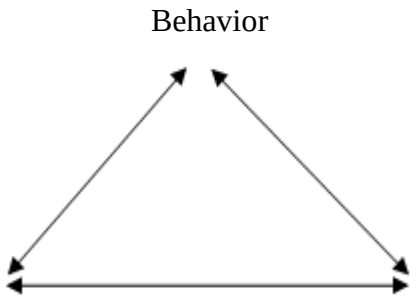

Figure 1: Bandura Model

Source: Bandura, 1977

Social learning theory rest heavily on the concept of modeling or learning by observing behavior. Bandura (1977) outlines three types of modeling stimuli to include:

- **Live Model:** This involves an actual person demonstrating the desired behavior. This is applicable in demonstration teaching techniques.
- **Verbal Instruction Model:** This involves an individual describing the desired behavior in detail who instructs the participants on how to engage in the behavior. This is an application in the enquiry teaching approach.
- **Symbolic Model:** This involves modeling occurring by means of the media which include movies, television, internet, radio and literature. This modeling has a wide application in the computer-assisted instruction approach. According to Bandura (1977) whatever information is gleaned from observation, is influence by the type of model as well as a series of the following cognitive and behavioral processes:
- **Attention:** In order to learn or observe behavior, the observer must pay attention. Any damper on attention decreases learning. For example, if an observer is sleepy, groggy, drugged, sick, nervous or hyper, learning is decreased. Accordingly, the characteristics of a model influences attention. For example, if a model is colorful and dramatic, attractive or prestigious, appears to be particularly competent. Computer-assisted instructional approach adapts these variables. The use of televisions has a high enhancing influence on students' performance and retention.
- **Retention:** In order to reproduce (remember) an observed behavior, the observer must remember features of the behavior (imagery and language). The observer (learner) features what the model is doing in the form of mental images or verbal descriptions. When these features are stored, they can later be "brought up" for the purpose of reproduction in the learner's behavior. This process is consequently, influenced by observers' characteristics (cognitive capabilities, cognitive rehearsal) and event characteristics (complexity).
- **Reproduction:** This involves translation of the images or description into actual behavior. Observer's characteristics that affect reproduction include cognitive capabilities and previous performance.
- **Motivation:** The decision of an observer (learner) to reproduce or refrain from reproducing an observed behavior is dependent on the motivations and expectations

of the observer along with the anticipated consequences and internal standards. Smith (1984), opines that social learning is a powerful principal of operation of demonstration method. In this method, the student observes another person (teacher) who serves as a model and then proceed to imitate what the model does. Social Learning is facilitated by a number of factors which includes attention, memory, motor skills, reinforcement, and identification.

Demonstration Teaching Method

The demonstration teaching method is an instructional approach that involves the presentation and illustration of concepts through visual and experiential means. It aims to engage students actively in the learning process by providing them with real-life examples, practical demonstrations, and hands-on experiences. This method holds great potential for enhancing student learning outcomes, as it caters to different learning styles and encourages active participation. This method aims to enhance student understanding, motivation, and retention of knowledge. The demonstration teaching method, which involves visual presentations and experiential learning, has the potential to significantly impact students' academic performance in grasping carbohydrate concepts. Numerous studies have investigated the impact of the demonstration teaching method on students' academic performance in understanding the concept of carbohydrates. These studies consistently demonstrate the positive influence of visual and experiential learning in enhancing students' comprehension and knowledge retention.

For instance, a study by Linn et al. (2018) implemented the demonstration teaching method to teach carbohydrate structures and functions to undergraduate students. The researchers found that students who were exposed to demonstrations and hands-on activities had a significantly higher level of understanding compared to those who received traditional lecture-based instruction. The visual representation of carbohydrate structures and the opportunity to engage in practical activities improved students' ability to recognize and apply carbohydrate concepts. Similarly, in a study by Chen and Wang (2019), high school students were taught carbohydrate metabolism using the demonstration teaching method. The findings revealed that students who participated in demonstrations and laboratory experiments had significantly better performance on assessments and a deeper understanding of carbohydrate metabolism compared to students in a control group. The hands-on experiences allowed students to observe the biochemical processes involved in carbohydrate metabolism, leading to a more comprehensive understanding of the concept.

Empirical studies have consistently demonstrated the positive impact of the demonstration teaching method on student learning outcomes. For instance, a study by Ravi and Sankar (2015) reported that the demonstration teaching method led to improved student understanding and higher retention rates compared to traditional lecture-based instruction. Furthermore, research has shown that the demonstration teaching method can enhance student motivation and engagement. By making the learning experience interactive and experiential, students are more likely to develop a positive attitude towards the subject and feel a sense of ownership in their learning (Baram-Tsabari & Yarden, 2017). This increased motivation can lead to improved academic performance and a deeper interest in the topic.

Overall, the demonstration teaching method has proven to be an effective instructional approach in various disciplines. The visual and experiential nature of the method engages students actively, promotes deeper understanding, and enhances motivation and retention of knowledge.

Benefits of the Demonstration Teaching Method

Numerous studies have highlighted the benefits of the demonstration teaching method in promoting student learning. Firstly, visual learning is a key component of this approach, allowing students to observe and understand complex concepts more effectively. The use of visual aids, such as models, diagrams, and multimedia presentations, enhances students' comprehension and retention of information (Hake, 2016). Additionally, demonstrations provide concrete examples and practical applications, making abstract concepts more relatable and tangible to students (Stieff, 2016).

Furthermore, the demonstration teaching method facilitates experiential learning, as students actively participate in the learning process. By engaging in hands-on activities, experiments, and simulations, students develop a deeper understanding of the subject matter and gain valuable problem-solving and critical thinking skills (Sherin et al., 2013). This method promotes active engagement, as students can observe and analyze the outcomes of the demonstration, fostering a deeper connection with the content (Beghetto & Kaufman, 2013).

Challenges and Best Practices

While the demonstration teaching method offers significant benefits, it is not without challenges. One common challenge is the availability of resources and equipment needed for demonstrations, which can be costly and time-consuming to acquire and set up (Asghar et al., 2012). Additionally, managing a large class and ensuring that all students have a clear view of the demonstration can be challenging (Katz, 2017). However, with careful planning and implementation, these challenges can be overcome.

To ensure the effectiveness of the demonstration teaching method, several best practices should be considered. Firstly, clear and explicit explanations should accompany the demonstrations to provide context and reinforce key concepts (Fernandez et al., 2014). Additionally, incorporating opportunities for student interaction, such as asking questions, encouraging discussions, and providing hands-on activities, enhances student engagement and understanding (Levy & Petrulis, 2012). Moreover, aligning the demonstrations with the curriculum objectives and learning outcomes ensures relevance and meaningfulness for students (Huang et al., 2018).

The demonstration teaching method has proven to be an effective instructional approach for enhancing student learning outcomes. Its visual and experiential nature engages students and promotes active participation, resulting in improved comprehension, motivation, and knowledge retention. While challenges exist, careful planning, clear explanations, and meaningful student interactions can maximize the effectiveness of this method. Future research should focus on exploring the impact of the demonstration teaching method in various disciplines and contexts, as well as investigating its long-term effects on student learning.

Inquiry Teaching Method

The method involves the mental process of assimilating principles and concepts such as observing, describing and inferring where students are systematically acquainted with scientific and logical rules used to verify concepts and ideas with very little teachers' intervention (Klahr & Nigar, 2000). According to Inyang (1993) effective science teaching allows students to explore their environment and discover nature. Inyang opined that, to successfully adopt the inquiry approach, students must perform certain mental processes such

as observing, classifying, measuring, predicting, inferring and hypothesizing. A lot of inquiry prevails in the classroom with the teacher acting as a motivator, getting from point-to-point to guide the learning of students and helping them overcome difficulties. The teacher performs the role of a resources person who guides the learners' sources of information. According to Klahr and Nigam (2004), inquiry teaching requires the learners to group, synthesize, analyse, search for new information, discard useless information, transfer ideas and in general, re-organize his thinking.

Inquiry teaching engages learners in problem solving to make a discovery, as describe by mayer (2004). According to kirschner, Sweller, & Clark (2006) the role of the teacher is to create the conditions for intervention rather than provide ready-made knowledge. The instructional design of inquiry learning provides students with a problem and the opportunity for exploration to formulate solutions to the problem. The teacher guides the development of problem solving skills and the creativity of the students. Guided-inquiry learning works on the assumption that students are more likely to retain knowledge if they discover it on their own. Students benefit from this type of instruction because it fosters curiosity and creativity.

Inquiry teaching is process by which student experience the power and usefulness of sciences in the world around them. It also provides a consistent context for learning and applying sciences. Problem situation establish a "need to know" and foster the motivation for the development of concept (NCTM, 1989).

Retention

Retention of knowledge means recalling or remembering pieces of knowledge, processes, or skills that were learned earlier in time (Semb and Ellis, 2004). Retention, according to Coffey (2000) is a term used to denote how much learning of a particular concept has been maintained over time. According to Herron (1994), retention is an act of keeping something rather than losing it; the ability to remember things. In academics the term refers to learner's ability to recall information or materials learnt after a given time lag. The retention is forgetting, which is defined as the loss of information overtime.

It is obvious that memory has significant role in the knowledge retention. It is suggested that students gain memory systems as they carry out their classroom experiences by internalizing structures of classroom activities (Nuhall, 2001). Activities in classroom can be used as stimulus for memorization (Engelbrecht, Harding & Du Preez, 2007). Chauhan (2000) averred that every teacher is confronted with the problem of how to improve the retention ability of his students. Chauhan suggested six ways of improving retention which include: over learning, meaningfulness, and organization of subject matter, use of more manic device, self-recitation, formation of clean concept and the use of the principles of learning by doing. In these factors, the teacher's role is very crucial in enhancing retention ability of the child. This can only be done through meaningful and effective presentation of the instructional content in an interactive way that will encourage effective participation of the leaner in the teaching /learning process.

According to interactive inference theory (Lehman & Malmbreg, 2009), when you are learning a great deal of information at one time, you tend to remember best what is read or presented first and last. The key to avoiding this problem is to look for connection and relationship between ideas so that they can be filed together or at least combine, without having any problem. Lehman & Malmbreg (2009) also, stated that human memory works on two different levels which are short and long term memory. Short term memory includes what you focus on in the moment, what holds your attention. To learn information so that you

can retain and recall, you must transfer it from short term to long term memory. Long term memory includes all the information that you can know and can recall and will have access to it for a long time. Knowledge retention is a significant goal of education (St. Clair, 2005). In line with work of Semb and Ellis (2004), the school exists to apply the effective teaching strategies that enhance ability of learners to recall biological facts taught in school.

Computer Assisted Instruction Approach

This is an approach which makes use of information and communication Technology to pass academic information to learners (Sambo, 2002). There are many Computer-Assisted Instructional (CAI) packages in different subjects in the present time. Sambo opined that Information Communication Technology (ICT) is part of globalizing agent used in turning the world to a "global village". Information and Communication Technology (ICT) is changing the way people learn, and offering new alternatives to the traditional classroom (Adigun and Zosu, 2012). Salua (2012) enumerate the benefits of Computer-Assited Instruction to include the provision of resources and the pedagogical framework for enabling pupils to become effective independent learners, among others. According to Wali (2001), Information Technology devices comprise of various kinds and sizes of computers. However, Roblyer (2003) looked at a computer as a set of devices that designed to work together to accomplish input, processing, and output functions in order to accomplish tasks desired by a user.

No education system can afford to stay outside the knowledge age while operating in a world that is now run by knowledge. So the way out of the dilemma is the integration of computer application in the teaching and learning of Biology for the attainment of Millennium Development Goals (MDGs). The current trend in research all over the world is the use of computer facilities and resources to enhance teaching and learning.

Cotton (1977) in his analyses on computer aided instruction concluded, among others, that the use of Computer-Assisted Instruction (CAI) as supplement to traditional method of teaching produces higher achievement than the use of only traditional teaching method. He further established that students learn biology contents faster with CAI than with conventional instruction alone, and that CAI activities appear to be least as effective as and sometimes more cost effective than other teaching methods. It has been variously established in the past, that computer aided instruction enhanced students' performance more than the conventional teaching methods in counselling education. In science Education, of which biology is one, Ahmed's (2007) finding was that CAI is fairly more successful than teacher centred education method in increasing academic achievement and performance. This is a teaching technique in which a student interacts with a computer system (Nwoji, 2002). It is interactive, the students respond to instructions presented to him/her by the computer. CAI involves the learner and the teacher. It is an active, not passive, instructional medium. New information/knowledge can be taught to the student with or without a human teacher. CAI also allows the students to review or practice skills previously taught (Awotua – Efebo, 2001).

In science classroom, the micro-computer can be used for a number of purposes such as; lesson planning, science instruction, management of science instruction and evaluation. Today, it is not uncommon to find micro-computers in our school science classrooms. Computers because of their speed, efficiency and flexibilities are indispensable tools in almost all facets of human endeavour. In a computer age such as ours, the computer finds

immense use in our homes, schools, offices, stores, banks, hospitals, military, radio and television houses (Aniodoh, 2001).

The computers can be used to aid science instruction. Computer-Assisted instruction (CAI) enables a lesson to be delivered through a computer without constant teacher interaction. To make the science learning interesting and worthwhile, the computer-assisted programme must be carefully planned. Good planning should give serious consideration to the content, methodology, instructional objectives and evaluation of a science lesson. Thus in selecting computer programmes a good science teacher should pay a great deal of attention to those programmes that are relevant, meaningful and worthwhile. Such programmes will to large extent, motivate and stimulate students. As a Computer- Assisted instruction must be carefully planned, it is essential that the students be given list of both performance and process objectives. These will help them know what is required of them as they work at the micro-computers (Aniodoh, 2001).

Students' Academic Performance on the Concept of Carbohydrate

The concept of carbohydrates plays a crucial role in understanding the structure, function, and importance of these macromolecules in biological systems. Students' academic performance on the concept of carbohydrates is of great significance, as it reflects their level of understanding and proficiency in related scientific fields. However, understanding carbohydrates is essential for students studying biology, biochemistry, nutrition, and related fields. However, several factors can influence students' academic performance in this area:

Prior Knowledge and Prerequisites: Students' academic performance on the concept of carbohydrates can be influenced by their prior knowledge and understanding of related concepts. Adequate coverage of prerequisite knowledge and skills is necessary to ensure that students have the foundational understanding needed to grasp carbohydrate concepts. Identifying and addressing gaps in prior knowledge can significantly improve academic performance (NRC, 2012).

Instructional Strategies: The choice of instructional strategies greatly impacts students' academic performance. Effective strategies include a combination of lectures, discussions, visual aids, and hands-on activities as well as textbooks, laboratory manuals, and online resources can impact students' learning outcomes. For example, interactive lectures with visual representations of carbohydrate structures and functions, supplemented with demonstrations and experiments, have been found to enhance students' understanding (Wright et al., 2014). Access to well-designed materials that provide clear explanations, relevant examples, and interactive learning opportunities can positively influence academic performance.

Curriculum Design: The design of the curriculum plays a crucial role in students' academic performance on carbohydrate-related topics. A well-structured curriculum should provide a systematic and progressive approach to teaching carbohydrates, ensuring that foundational concepts are covered before moving to more complex topics. Additionally, integrating real-life applications and examples into the curriculum can enhance students' understanding and engagement (NRC, 2012).

Assessment Methods: Appropriate assessment methods are essential for evaluating students' academic performance on the concept of carbohydrates. Assessments should align with the learning objectives and reflect the depth of understanding required. Traditional assessments, such as multiple-choice questions, may assess factual recall, while performance-based

assessments, such as laboratory experiments or research projects, can assess higher-order thinking skills and the application of carbohydrate concepts (Becker et al., 2013).

Teaching Strategies: The instructional methods employed by educators play a crucial role. Traditional lecture-based approaches may not effectively engage students in carbohydrate-related topics. Employing active learning strategies, such as inquiry-based learning, problem-solving activities, and hands-on experiments, can enhance understanding and improve academic performance.

Student Engagement: Actively engaging students in the learning process is essential. Encouraging participation through discussions, group activities, case studies, and real-life applications can foster a deeper understanding of carbohydrates. Promoting student engagement and interaction can lead to improved academic performance.

Individual Differences: Students have different learning styles, cognitive abilities, and prior experiences that can influence their academic performance. It is crucial to employ diverse teaching strategies and instructional approaches to cater to these individual differences and promote equitable learning opportunities for all students.

Teacher Support and Feedback: The guidance and feedback provided by teachers play a vital role in supporting students' academic performance. Timely and constructive feedback can help students identify and rectify their misconceptions and improve their understanding of carbohydrates.

It is important to note that the factors influencing students' academic performance on the concept of carbohydrates may vary in different educational contexts and student populations. Further research and empirical studies can provide more specific insights and evidence-based strategies for enhancing students' learning outcomes in this area.

Conclusion

The choice of teaching methods significantly influences students' academic performance on the concept of carbohydrates. While demonstration teaching method remains a common instructional approach, their effectiveness can be enhanced by incorporating visual aids and multimedia resources in enhancing student learning outcomes. Inquiry learning promote active engagement and critical thinking, leading to improved comprehension and knowledge retention. Also, incorporating other approach, such as retention approaches and computer-assisted instructional (CAI) approaches, can significantly enhance students' academic performance on the concept of carbohydrates. Educators should carefully consider the selection and implementation of teaching methods based on the specific needs and characteristics of their students. Combining different instructional strategies and incorporating interactive elements can maximize students' understanding and academic achievement regarding carbohydrate concepts.

Recommendations

Based on the literature reviewed, the following recommendations can be made for enhancing the teaching methods and academic performance of students on the concept of carbohydrates:

1. Educational institutions should incorporate visual aids such as diagrams, models, and multimedia presentations to supplement lectures. Visual representations help students visualize complex carbohydrate structures and functions, facilitating better understanding and knowledge retention.

2. Educational institutions should integrate inquiry-based learning approaches into carbohydrate education. Engage students in hands-on activities, laboratory experiments, and problem-solving exercises. This approach promotes critical thinking, conceptual understanding, and long-term retention of carbohydrate-related knowledge.

3. Educators should address identify and address students' prior knowledge gaps related to carbohydrate concepts. Provide a solid foundation by covering prerequisite knowledge and skills necessary for understanding carbohydrates. Targeted instruction and support for students with varying levels of prior knowledge can enhance their academic performance.

4. Educators should recognize the diverse learning needs and preferences of students. Adapt teaching methods and materials to accommodate different learning styles, ensuring that instructional approaches are accessible and engaging for all students.

5. Educational institutions should encourage educators to engage in professional development opportunities focused on effective teaching methods and strategies for carbohydrate education. Ongoing training and sharing of best practices among educators can improve instructional approaches and enhance student academic performance.

6. By implementing these recommendations, educators can create an engaging and effective learning environment that promotes students' comprehension, knowledge retention, and overall academic performance on the concept of carbohydrates.

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