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Article

Analysis of Students' Cognitive Dimension on Digestion Process

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Abstract

This research deals on the students' cognitive dimension in biological concepts. This was participated by the Grade 8 students of the Mindanao State University at Naawan- Integrated Developmental School, S.Y. 2018-2019. Thus, it primarily aims to find out the students' cognitive dimension in Biology. A researcher-made questionnaire for conceptual assessment consisting of four open-ended questions per topic in the digestion process was used. Results showed that students' conceptual understanding at 40% on the digestion process was memorizing dimension (level 1). This means that although students could properly define any piece of theoretical knowledge like in the books, students failed to utilize, apply, and exemplify the concepts.

Keywords: Cognitive Dimension, Understanding, Critical Thinking

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INTRODUCTION

1.1. Background and rationale

Biological knowledge is generally perceived by the students as a subject composed of factual information, thereby students greatly employ low-level thinking skills by just learning facts. Basically, these skills involve only memorizing, simple recalling, and understanding rather than on cognitive abilities that involve analyzing, synthesizing, and evaluating. Consequently, evidences revealed in System Admission and Scholarship Examination of the Mindanao State University that most of the first batch of senior high school graduates who took up the entrance examination were found out to be incompetent. Further, there are considerable evidences that teachers' knowledge, understanding and thinking skills are linked to students' learning and understanding (Goulding *et al.*, 2002). Thus, in order to improve student learning, understanding and thinking skills, mentors should equip the students with essential and life-long learning competencies and knowledge.

The current push for 21st century learning in the classroom stresses the importance of higher order thinking, a skill that students are expected to develop throughout all school levels and at their different subjects in their entire educational experience. Although there is ample information for educators on ways in which to promote higher order thinking in the classroom, there is one crucial piece of information missing: a common definition of higher order thinking in K–12 classroom settings (Sydoruk, 2018). Brookhart (2010) described higher order thinking as students being able to relate their learning to other elements beyond those they were taught to associate with it, such as relating the content to prior knowledge or making connections outside of the curriculum. He avowed that higher order thinking includes critical thinking as an essential component of skill set development. Critical thinking, which encompasses skills of reflection and reasoning, builds higher order thinking skills and the ability to make decisions in order to solve problems and complete tasks.

Many teachers in the school system today do not understand fully critical thinking, itself. Critical thinking is more than asking the content in different ways to try to raise a logical answer. Teachers get students to regurgitate information on tests, otherwise known as memorization, which is a method of lower order thinking. This means that teachers must first fully understand the methodology of asking higher order thinking questions so that students may understand how to think on the level (Choy and Cheah, 2009). Questioning helps students to move from the lower level recall ability to higher level evaluation and synthesis. This provides structure in helping students beyond basic knowledge that is typically asked on standardized tests to a deeper conceptual understanding which allows for an easy transfer of knowledge from their understanding (Smith and Szymanski, 2013).

Apparently, higher order thinking is defined broadly by Newman (1991) as challenge and expanded use of the mind where a person must interpret, analyze, or manipulate information, because a question needs to be answered. He asserted that critical, logical, reflective, creative thinking and metacognitive skills can be subsumed under a more general distinction between higher order and lower order thinking. He further indicated that lower order thinking represents routine, mechanistic application, and limited use of the mind. Kings *et al.,* (2013)

pointed out that when students encounter unfamiliar problems, uncertainties, questions, or dilemmas activate mind.
A major component of the current reforms in science education worldwide is the shift from the dominant traditional teaching for algorithmic, lower-order cognitive skills, to higher-order cognitive/thinking skills (Leou *et al.,* 2006). This shift includes, among others, a scientific inquiry component, learning science within students' personal, social, and environmental contexts, and the integration of critical thinking (Zoller, 1993). Although the guiding ideas of science education reforms and the corresponding supporting teaching strategies have been, and are incorporated into teachers' pre-service courses and in-service professional development programs, a substantial portion of these strategies are not implemented in the teachers' classrooms (Barak and Dori, 2005). Indeed, the design and implementation of teaching strategies that enhance higher-order thinking among students are not a simple endeavor; they challenge even the most expert teachers (Tobin *et. al.,*1990).
Critical thinking (CT) in this study is conceptualized as an operative example of higher order thinking that can be accounted for due to reliable and validated tests. In the literature, CT has been defined as a skill of taking responsibility and control of our own mind (Paul,1996), or as a logical and reflective thought which focuses on a decision in what to believe and what to do (Ennis, 1985). Critical thinking involves a variety of skills such as the individual identifying the source of information, analyzing its credibility, reflecting on whether that information is consistent with their prior knowledge, and drawing conclusions based on their critical thinking (Linn, 2000). In the literature, CT skills are considered to be essential for the promotion of metacognitive understanding (Schraw *et al.,* 2006).

In view of the importance and the need of immediate attention of promoting higher-order thinking skills in contemporary science education, this study aims to determine the students' cognitive dimension in Digestion Process?

1.2. Significance of the study

The findings of this research hopefully aims to address the existing problems of the present time in delivering quality instruction. Thus, this aims to provide significant information to the following stakeholders:

Science Teachers. The result of this research helps Science teachers to become more aware of what they can do to meet the desired students' learning competencies. This would also allow them to reflect and assess themselves in terms of their efficiency and efficacy to facilitate learning and eventually apply the necessary steps to improve or enhance students' cognitive abilities as to how they would critically conceptualize and apply them on real life scenarios.

Pre-service teachers. The result of this research provides an opportunity for the practice teachers to picture out how they would facilitate learning not merely on acquiring facts and information by discovering teaching strategies and methods to use where students can think out from the box, and most importantly develop themselves an art of questioning techniques for the students to improve their critical thinking skills.

Administrators. The result of this research, shall serve as an eye-opener for them to hire competent teachers who have facilitative skills, broad background of understanding in their field of specialization, ability to teach the subject matter conceptually, and communication skills.

Students. The result of this research allows them to reflect themselves that knowing facts is not enough. Since students are taught based on conceptual applications, they should be able to realize the importance of higher order thinking skills, that in their journey of education they would be taking examination which is a combination of facts and application.

Future researchers. The result of this research shall serve as a benchmark for them who would wish to expand the scope of this study.

1.3. Theoretical framework

This study is anchored on the four learning theories. First, is on the Webb's Depth of Knowledge (Webb *et al.*, 2005). This framework on thinking consists of four levels of thinking that range from basic recall to strategic and creative thinking. Each level also provides a list of keywords that teachers could use in the classroom in order to create questions and problems with more depth and rigor. Level 1, the lowest level focuses on recalling facts and contains keywords such as tell, recognize, and quote. Level 2 focuses on skills and concepts where students use learned concepts to answer questions. By Level 3, students are asked to think strategically through developing a logical argument and drawing conclusions. The fourth and highest level focuses on extended thinking and asks students to critique, synthesize, and analyze (Hess *et al.*, 2009).

The second framework on thinking is the Bloom's Revised Taxonomy (Bloom *et al.*, 1956). The taxonomy organizes levels of complexity based on actions and contains six levels of complexity, ranging from the most basic task of remembering information to the highest level of creating. Similar to Webb's Depth of Knowledge, the lowest level of Bloom's Revised Taxonomy focuses around recall, memorizing, and repeating facts that had been taught. The next level, concentrates on understanding, contains actions including classify, describe, and recognize. The third level shows more abstract concepts through applying information and solving problems (Hess *et al.*, 2009). Further along on the taxonomy are tasks that contain more cognitive complexity, such as analyzing, evaluating, and creating. These performance tasks require students to use dynamic global society and to successfully meet the challenges and opportunities of the 21st century global workplace" (New Jersey Department of Education, 2017).

The third theory of learning anchored to knowledge transmission where students learn how to acquire knowledge. It is in this aspect related to the processes through which students acquire knowledge that constructivist teaching and learning theory have much to offer. Constructivist teaching and learning theory advocates a participatory approach in which students actively participate in the learning process. For Ernest von Glaserfeld (1989) constructivism as a theory of knowledge puts forward the following two principles: “knowledge is not passively received but actively built up by the cognizing subject; and the function of cognition is adaptive and serves the organization of the experiential world, not the discovery of ontological reality”. The core of the constructivist approach to teaching and learning as expounded by von Glaserfeld is that the student or the learner is an active participant in the learning process and that the teacher has to take account of that in the teacher’s effort to facilitate learning. He also makes an effort to link the theory of constructivism to the practice of teaching. Science education reforms worldwide are derived from the constructivist views of teaching and learning. These reforms explicitly ask teachers to change their teaching strategies by shifting the emphasis from the traditional textbook-based, rote learning, to exploration, inquiry-based learning situated in real-world phenomena (National Research Council,1996). The third constructivist theory recognizes that students need to be exposed to learning experiences that enable them to construct their own knowledge and promote their thinking skills (Cobb *et al.*,1994).

Lastly, cognitive psychologists saw a new way to look at how people processed information. One of the theories that serves to describe the process of learning is the Information Processing Theory. According to cognitive psychologists, learning can be defined as a change in a person’s mental structures that creates the capacity to demonstrate different behaviors (Eggen and Kauchack, 2007). Information Processing Theory looks closely at how, independent of the context, stimulation from the environment goes through the processes of attention, perception, and storage throughout a series of distinct memory stores. Educators are very interested in the study of how humans learn. This is because how one learns, acquires new information, and retains previous information guides selection of long-term learning objectives and methods of effective instruction. To this end, cognition as a psychological area of study goes far beyond simply the taking in and retrieving information. It is a broad field dedicated to the study of the mind holistically. Neisser (1967), one of the most influential researchers in cognition, defined it as the study of how people encode, structure, store, retrieve, use or otherwise learn knowledge. Cognitive psychologists hypothesize an intervening variable or set of variables between environment and behavior—which contrasts it with behavioral theories.

2. MATERIALS AND METHODS

2.1. Subject of the study

The respondents of the study were the Grade 8 students in Biology of the Mindanao State University at Naawan- Integrated Developmental School enrolled during the School Year 2018-2019. The grade level was composed of 3 sections, grouped homogenously based on their academic performance in the previous academic year. The respondents were from section Arguelles, Bellardo, and Celis, with a class size of 42, 41, and 43, respectively.

Mindanao State University at Naawan- Integrated Developmental School is a laboratory school of the College of Education and Social Sciences of MSU-N. It is one of the best training centers for secondary schools governed by the Mindanao State University System.

2.2. Conceptual questionnaire

A researcher-made questionnaire for conceptual assessment consisting of four open-ended questions in the digestion process was used.The first question required students to discuss the concept and draw a diagram that further explains the process of digestion. Second, students were asked to explain the digestive juices that aid during digestion. Third, students were asked to differentiate the chemical from the mechanical digestion. Lastly, students were asked to explain as to how our stomach is protected from acid chyme.

2.3. Cognitive dimension scoring analysis

Students' responses in the researcher-made conceptual questionnaire were evaluated using the cognitive dimension rating analysis of Saglam (2004). This model of understanding was used to classify the types of students' perceived knowledge as shown in Table 1.

Table 1. Classification of students' cognitive dimension and their characteristics

Level	Model of Understanding	Characteristics
5	Optimum Dimension (OD)	Student properly defines, utilizes, applies and exemplifies any piece of theoretical knowledge.
4	Uncreative Dimension (UD)	Student properly defines, utilizes, and applies any piece of theoretical knowledge but fails in exemplifying it.
3	Theoretical Dimension (TD)	Student properly determines and defines any piece of theoretical knowledge but fails in applying and exemplifying it.
2	Practical Dimension (PD)	Theoretical knowledge but fails in determining and defining it.
1	Memorizing Dimension (MD)	Student properly defines any piece of theoretical knowledge as the books do but fails in utilizing, applying, and exemplifying.
0	Inappropriate Dimension (ID)	Student fails defining, utilizing, applying, and exemplifying any piece of theoretical knowledge.

2.4. Data analysis

The data were collected and analyzed quantitatively. The following statistical tools were used in interpreting the data.

1. Percentage

It was used to present students' performance in Biology

$$\% = \frac{fi}{nx} x100$$

Where:

fi is the frequency of the i^{th} response

n is the total number of response

2. Mean

It was used to present and analyze the perception of the students towards Biology.

$$\frac{\mu = \sum_{i=2}^{n} fixi}{n}$$

Where:

fi is the frequency of the i^{th} response

is the value of the response

n is the total number of response

3. RESULTS AND DISCUSSION

3.1. Students' cognitive dimension in Digestion Process

Figure 1 shows the students' cognitive dimension in digestion process. The result shows that 40% of their conceptual understanding on the digestion process and on the circulation process is memorizing dimension (level 1). This means that although students could properly define into any piece of theoretical knowledge like in the books, students failed to utilize, apply, and exemplify the concepts. One can infer that students might have obtained the mastery level by merely memorizing concepts but without analysis, synthesis, and application of concepts. Relatively, analysis of a study participated by pre-service teachers revealed that the student teachers' have significant weaknesses in understanding the terms of fundamental knowledge of Newton's Laws of Motion. This may stem from the lack of student teachers to relate scientific knowledge with real life phenomena and experiences. Another result of this study is that defining the level of understanding and model of understanding students can help educators to prepare and implement teaching activities more effectively to promote students' thinking, discussing and interpreting skills (Saglam-Arslan and Devicioуglu, 2010).

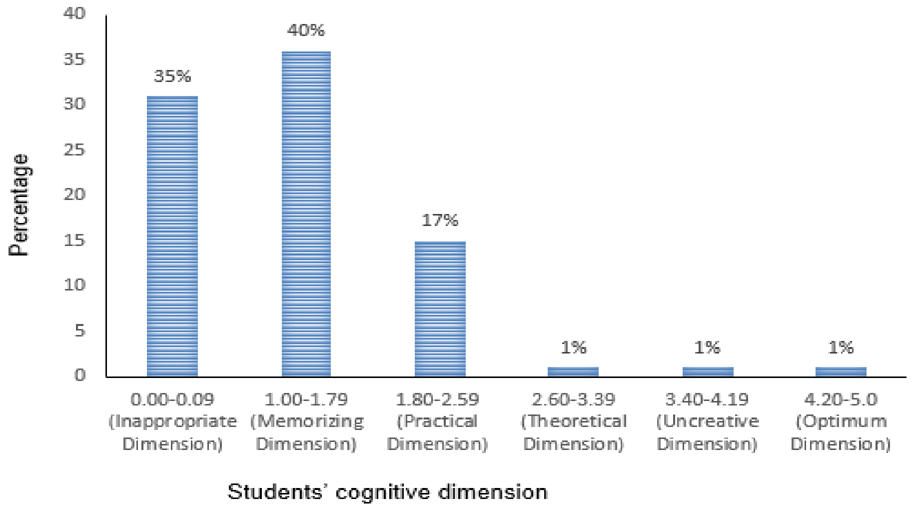

Figure 1. Percentage distribution of students' cognitive dimension in digestion circulation process

To look into the students' cognitive dimension for each topic, Table 2 presents the students' cognitive dimension on digestion process. The mean score of the students' cognitive dimension for digestion process is 1.50 at memorizing dimension (Level 2).

Table 2. Results on students' cognitive dimension on digestion process

Items	Mean	Interpretation	Level
1.Discuss the digestion process, then draw a diagram that presents the passageway of the food up to the rectum.	2.14	Practical dimension	2
2.How do digestive juices facilitate the absorption of nutrients in our body?	1.11	Memorizing dimension	1
3.How do chemical and mechanical digestion work together to breakdown foods?	1.83	Practical dimension	2
4.How is our stomach protected from the acid chyme?	0.93	Inappropriate dimension	0
Total mean score	1.50	Memorizing dimension	1

Table 2 implies that students were able to trace the passageway of the food from the mouth, esophagus, stomach, small intestine, large intestine, until the material is stored at the rectum ready for excretion via anus. Further, they were able to discuss that once the food (chyme) reaches the small intestine there are substances that would aid and promote the breakdown of nutrients. In general, they know that there are substances that would help during the digestion process but they failed to identify the substances and their respective functions except for saliva, acid, and bile which were the common responses. Majority of the students' cognitive dimension falls under practical dimension. It can be deduced that students have the theoretical knowledge but were not able to determine and identify the functions or roles of the various substances needed during digestion process.

4. SUMMARY AND CONCLUSION

Through conceptual assessment, the results showed that 40% of their conceptual understanding on the digestion process and on the circulation process is memorizing dimension (level 1). This means that although students can properly define any piece of theoretical knowledge as the books discussed, students failed to utilize, apply, and exemplify the concepts. Furthermore, students' responses can be analyzed that they were able to trace the passageway of the food from the mouth, esophagus, stomach, small intestine, large intestine, until the material is stored at the rectum ready for excretion via anus. Further, they were able to discuss that once the food (chyme) reaches the small intestine there are substances that would aid and promote the breakdown of nutrients. In general, they know that there are substances that would help during the digestion process but they failed to identify the substances and their respective functions except for saliva, acid, and bile which were the common responses. Majority of the students' cognitive dimension falls under practical dimension which can be deduced that students have the theoretical knowledge but were not able to determine and identify the functions or roles of the various substances needed during digestion process.

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