Faculty of Cognitive Sciences and Human Development

FORM 4 BIOLOGY STUDENTS’ DRAWINGS AND MISCONCEPTIONS OF THE HUMAN DIGESTIVE SYSTEM

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FORM 4 BIOLOGY STUDENTS' DRAWINGS AND MISCONCEPTIONS OF THE HUMAN DIGESTIVE SYSTEM

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Statement of Originality

The work described in this project, entitled “Form 4 biology students’ drawings and misconceptions of the human digestive system” is to the best of the author’s knowledge that of the author except where due reference is made.

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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statement of Originality</td>
<td>i</td>
</tr>
<tr>
<td>Acknowledgement</td>
<td>ii</td>
</tr>
<tr>
<td>Table of Contents</td>
<td>iii</td>
</tr>
<tr>
<td>List of Tables</td>
<td>vi</td>
</tr>
<tr>
<td>List of Figures</td>
<td>vii</td>
</tr>
<tr>
<td>Abstract</td>
<td>viii</td>
</tr>
<tr>
<td>Abstrak</td>
<td>ix</td>
</tr>
</tbody>
</table>

**CHAPTER ONE INTRODUCTION**

1.0 Introduction

1.1 Background of study
   1.1.1 Memory and level of knowledge
   1.1.2 Connected knowledge
   1.1.3 Learners' prior knowledge and misconceptions
   1.1.4 Scientific knowledge
   1.1.5 Discussion concerning knowledge

1.2 Problem statement

1.3 Objectives
   1.3.1 General objective
   1.3.2 Specific objectives

1.4 Research Questions
   1.4.1 General research question
   1.4.2 Specific research questions

1.5 Theoretical framework

1.6 Significant of the study

1.7 Limitations of the study

1.8 Definitions of terms
   1.8.1 Misconception
   1.8.2 Human digestive system
   1.8.3 Drawing

1.9 Summary

**CHAPTER TWO LITERATURE REVIEW**

2.0 Introduction

2.1 Misconceptions
   2.1.1 Misconceptions: View of constructivist framework
   2.1.2 Misconceptions in biology
   2.1.3 Source of misconceptions
   2.1.4 Conceptual change

2.2 Drawing: tool for identifying concepts

2.3 Methods in identifying misconceptions in biology
   2.3.1 Interview
   2.3.2 Open-ended and close-ended questions
CHAPTER THREE METHODOLOGY

3.0 Introduction 29
3.1 Research design 30
3.2 Population, sample and sampling procedure 31
3.3 Instrument for data collection 32
3.4 Pilot study 35
3.5 Validity and reliability 36
3.6 Ethics in the study 37
3.7 Data collection procedure 38
3.8 Data analysis procedure 39
3.9 Summary 40

CHAPTER FOUR FINDINGS

4.0 Introduction 41
4.1 Students' drawing of human digestive system 42
  4.1.1 Disconnected organs in drawing 42
  4.1.2 Connected organs in drawing 45
  4.1.3 Overview of drawing 56
4.2 Explanation of human digestive system based on drawing 56
  4.2.1 Simple drawing with detailed explanation 56
  4.2.2 Simple drawing with limited explanation 57
  4.2.3 Confusion of term 57
  4.2.4 Conflict between drawing and explanation 59
  4.2.5 Additional information on drawing 60
  4.2.6 Overview of drawing and its explanation 62
4.3 Students' misconceptions generated by drawing 63
  4.3.1 Organs from other human system in digestive system 63
  4.3.2 Sequence and connectivity of organs in human digestive tract 63
  4.3.3 Organs and its shape 64
  4.3.4 Functions of organs 64
4.4 Students' misconceptions on human digestive system generated by questionnaire 65
  4.4.1 Path of food in digestive tract 65
  4.4.2 Matter 67
  4.4.3 Movement of food down the digestive tract 67
LIST OF TABLES

Table 3.1
The open ended questions and its target content knowledge 34
LIST OF FIGURES

Figure 1.1
Theoretical framework of study 10

Figure 3.1
Drawing of student 4 with pancreas 39

Figure 4.1
Drawings of student 6 with intestine and stomach 43

Figure 4.2
Drawing of student 9 with unclear entrance and exit for food 43

Figure 4.3
Drawing of student 8 with kidney 45

Figure 4.4
Drawing of student 7 with the present of three organs 46

Figure 4.5
Drawing of student 2 with "intestines" 47

Figure 4.6
Drawing of student 3 with large intestine located prior to small intestine 49

Figure 4.7
Drawing of student 5 with cylindrical gall bladder 51

Figure 4.8
Drawing of student 1 with bolus in oesophagus 53

Figure 4.9
Drawing of student 10 with detailed outline 55
ABSTRACT

FORM 4 BIOLOGY STUDENTS’ DRAWINGS AND MISCONCEPTIONS OF THE HUMAN DIGESTIVE SYSTEM

Loren Pang

This research is a case study aimed to investigate Form Four Biology students’ drawings and misconceptions about human digestive system by using drawing, explanation and questionnaire in Kuching District, Malaysia. Ten students are selected from two secondary schools in Kuching District with purposive sampling. The instrument used in this study is self-developed by researcher based on the textbook of Form Two Science. It is divided into three parts that are drawing of human digestive system, probe questions for explanation based on drawing and semi-structured interview based on questionnaire. From the findings, students’ drawings of human digestive system can be divided into connected and unconnected organs in digestive system. Students show misconceptions in their drawing. With explanation of drawing, the understanding of student is verbalized where additional information is gained. Drawing can complement the information gained from student when student cannot verbalize their understanding. The misconceptions generated by drawing and questionnaire show different aspects of human digestive system but the misconceptions are interrelated. The curriculum should be intentionally organized in a way that provides student with a good grasp of abstract concepts in human digestive system during teaching and learning process of topic nutrition. Future studies should be conducted on larger scale of students and on other topics of biology.
ABSTRAK

LUKISAN DAN SALAH KONSEP PELAJAR TINGKATAN 4 TERHADAP SYSTEM PENCERNAAAN MANUSIA

Loren Pang

Kajian ini merupakan satu kajian kes yang bertujuan untuk menyiasat lukisan dan salah konsep pelajar Tingkatan Empat Biologi tentang sistem pencernaan manusia dengan menggunakan lukisan, penerangan dan soal selidik di Daerah Kuching, Malaysia. Sepuluh pelajar dipilih dari dua buah sekolah menengah di Daerah Kuching dengan persampelan bertujuan. Instrumen yang digunakan dalam kajian ini dibuat oleh penyelidik berdasarkan buku teks Tingkatan Dua Sains. Ia dibahagikan kepada tiga bahagian yang terdiri daripada lukisan sistem pencernaan manusia, soalan untuk penjelasan berdasarkan lukisan dan temuduga separa berstruktur berdasarkan soalan soal selidik. Daripada penemuan kajian ini, lukisan pelajar tentang sistem pencernaan manusia boleh dibahagikan kepada organ-organ yang bersambung dan tidak bersambung dalam sistem pencernaan. Pelajar menunjukkan salah konsep dalam lukisan mereka. Dengan penjelasan lukisan, pemahaman pelajar diperoleh melalui lisan memerlukan makanan tambahan. Lukisan boleh melengkapkan maklumat yang diperoleh daripada pelajar apabila pelajar tidak dapat menjelaskan pemahaman mereka menggunakan lisan. Salah konsep dalam aspek yang berbeza dalam sistem pencernaan manusia diperoleh daripada lukisan dan soal selidik tetapi salah konsep itu adalah saling berkaitan. Kurikulum perlu dianjurkan dengan cara untuk menyediakan pelajar dengan pemahaman yang lebih baik tentang konsep yang abstrak dalam sistem pencernaan manusia semasa proses pengajaran dan pembelajaran topic nutrisi. Kajian masa depan perlu dilaksanakan pada skala yang lebih besar dan dalam topik lain.
CHAPTER ONE

INTRODUCTION

1.0 Introduction

This chapter discusses the various aspects of knowledge, problem statement, research objectives, research questions, significant of the study, limitations of the study and also, definition of terms.
1.1 Background of the Study

Various aspects of knowledge will be discussed in the following section. Memory and level of knowledge will be discussed first, followed by connected knowledge. Additionally this section will detail prior knowledge, misconception and lastly, scientific knowledge.

1.1.1 Memory and level of knowledge

Level of knowledge can be divided into two, deep knowledge and surface knowledge. Deep knowledge is when learners are able to anchor his/her own knowledge with the external information that has been translated to basic concepts in the learners' mind. The knowledge has been processed and stored in memory where it is useful for application and task performance. Deep knowledge is associated with understanding while surface level knowledge is related to reproduction and rote learning. Surface knowledge stored in memory is similar to the copy of external information (Jong & Ferguson-Hessler, 1996).

Marton et al. (1993, as cited in Burnett, Pillay, & Dart, 2003) divided learning into two main types: surface learning with reproductive approach and deep learning. Surface learning involves memorizing, reproducing as well as application, where one's knowledge is increased. Understanding and seeing something in a different way, resulting in change in a person is the result of deep learning. Even though understanding and memorization often contradicted each other in the categorizing of learning, there is a paradox of learning for Asian students. Even though Asians seem to utilize surface learning by memorizing, they are high achievers. Besides memorizing, they do seek understanding (Kember, 1996).
Students in South Pacific describe learning as focusing on understanding using the metaphor of depth. For them, memorization can occur with the present or, without understanding (Mugler & Landbeck, 2000). Understanding requires memorization and memorization contributes to understanding of learner in a way.

1.1.2 Connected Knowledge

Belenky, Clinchy, Goldberger, and Tarule (1986, as cited in Hofer & Pintrich, 1997) listed out five perspectives of women’s view on knowledge which includes silence, received knowledge, subjectivism, procedural knowledge and constructed knowledge. Procedural knowledge requires reasoned reflection, applying objective and systematic procedures of analysis. The quality of knowledge involves an active learner who engages in procedures such as comparing and contrasting information from various sources. The learners need to continuously interpret the information before deciding which one to be incorporate into his/her current knowledge. The formation of procedural knowing can be divided into two, which are separated knowing and connected knowing. In separated knowing, the acquiring of knowledge is based on evidence where personal emotions are detached from the knowledge (Hofer & Pintrich, 1997). Connected knowing on the other hand, is personal and emphasizes understanding over judgment (Hofer & Pintrich, 1997; Zohar, 2006).

The few characteristics of connected knowledge are meaningfulness, supportiveness, and personalization, where the involvement of attachment, intimacy and feeling are present. In connected knowledge, learners need to understand the information gained. Here, learners will involve other elements in the
reasoning process. There will be the element of learners’ personal experience and relativeness of the knowledge to the learner where feelings are accounted in the knowledge construction process. Zohar (2006) argued that understanding is directly related with connected knowing.

1.1.3 Learners’ Prior Knowledge and Misconceptions

Before learners are introduced with formal science instruction, they have their own diverse set of concepts about how things work in their mind. These diverse set of concept are often referred to as, prior knowledge. Learners’ prior knowledge may cause misconceptions when they encounter scientific knowledge. These misconceptions are not bonded by the age, ability or gender of learners. Misconceptions may occur due to the personal experiences or formal instructions. The interaction of learner’s prior knowledge and formal instruction may result in unexpected learning outcomes (Bahar, 2003). Misconceptions can occur before or after being exposed to formal education. It is one of the factors that affect learning besides factors which related to the attitude, learning styles and motivational styles of students. Although there are also others terms such as naïve beliefs, preconceptions, alternative framework and alternative conception used to refer misconceptions, the term misconception is commonly used and convey the message that a concept might contradict with scientific knowledge in formal science education (Bahar, 2003; Tekkaya, 2002).
1.1.4 Scientific Knowledge

In Malaysia, the science curriculum comprises of three core science subjects and four elective science subjects. Biology is one of the elective science subjects offered in upper secondary level besides Chemistry, Physics and Additional Science. It is a subject for students who intend to study in-depth about living organisms, scientifically. These students are pre-equipped with the scientific background from foundational Science in primary school and lower secondary level. For example, the topic Analyzing Food Digestion in Form Four Biology is a continuation from the topic Understanding the Digestive System In Men from Form Two Science. In Form Two, the content focuses on organs' structure and function in human digestive system while in Form Four, the physiology and the chemical break down of food is explained in detail (Curriculum Development Centre, 2005; Curriculum Development Centre, 2002).

Based on the learning area of Nutrition in both Form Two Science and Form Four Biology, there is similarity between these two forms in terms of area of study. The learning objective in ‘Analyzing food digestion’ is the continuation of the learning objective in ‘Understanding the digestive system in men’ of Form Two Science. Human Digestive System will used to refer to both the learning objectives in this study.

In Form Two Science, students are required to achieve a few learning outcomes, which are similar to the learning outcomes in Form Four Biology. Form Two Science students should be able to explain what digestion is after learning about the ‘Human digestive system’. Moreover, they need to identify the parts of the digestive system and describe the flow of food particles in the alimentary canal.
Besides listing the end products of digestion of carbohydrate, protein and fats, they should also be able to state the functions of the organs in the digestive system.

Similarly, Form Four Biology students should be able to state the substances required by the cell to carry out metabolic processes after the lesson in Food Digestion. Furthermore, they are required to explain the necessity for digestion of complex substances. Besides that, they should be able to draw and label the human digestive system. In other learning outcomes such as state the digestive juices and substances that aid in the process of digestion in human, they are expected to describe the functions of the digestive juices and substances, and to list the complex substances that need to be digested.

Apart from the learning outcomes listed above, Form Four Biology has additional learning outcomes such as to identifying parts of the digestive system in ruminants and rodents involved in the digestion of cellulose. Moreover, students need to describe the digestion of cellulose in ruminants and rodents. They are also required to compare and contrast the digestive process in humans, ruminants and rodents. Experiments are also designed to study the digestion of starch and proteins in food samples along with description of problems related to food digestion.

1.1.5 Discussion Concerning Knowledge

From the various types of knowledge discussed above, we can summarise that knowledge are categorized into groups. Memory and prior knowledge is situated in the mind. Connected knowledge is also situated in the mind, but may occur externally if there is involvement of other elements. In contrast, scientific knowledge occurs externally.
1.2 Problem Statement

One of the goals in biology curriculum of Malaysia is to enable students to acquire knowledge in biology and technology in the context of natural phenomena and everyday life experiences (Curriculum Development Centre, 2005). This indicates that we need to identify the students' prior knowledge which they bring to class either from formal education or daily life experience before lesson is planned. Biology students are equipped with the basic knowledge of science in the core subjects which is Science in primary school level and lower secondary level. The topic Analyzing Food Digestion in Form Four Biology is a continuation from the topic Understanding the Digestive System In Man in Form Two Science.

Researches have been conducted on the topic human digestion system in other countries such as Turkey (Cakici, 2005; Cerrah Özseygeç, Artun, & Ünal, 2012; Ormanci & Ören, 2011), Brazil (Teixeira, 2000) and India (Mathai & Ramadas, 2006). Most research used quantitative analysis in the study (Mathai & Ramadas, 2006; Ormanci & Ören, 2011) while some used mixed method of qualitative and quantitative (Cakici, 2005). There is lack of qualitative studies in Malaysia on studies related to human digestive system by using drawing and verbal to identify misconceptions of Form Four biology students based on local curriculum. Therefore, it is necessary to carry out study on students ideas based on drawing and explanation.

The use of drawing in combination with written responses or interviews is recommended for getting more reliable information about learners on abstract concepts in Biology (Kose, 2008; Prokop & Fancovičová, 2006). However, research conducted by Mathai and Ramadas (2009) show that student expressed
the human body system better using text over drawing. This leads to the need of investigating the role verbal explanation and drawing in expressing understanding.

The ideas students gained in Form Two plays a crucial role in the learning of nutrition topic in Form Four. Students' ideas include standard scientific ideas and misconceptions. There is a need to determine the misconceptions as they will affect the students' subsequent learning (Tekkaya, 2002). However, before misconceptions can be corrected among the Form Four students, the misconceptions of students need to be identified. There is a need to determine students' explanation in nutrition Form Two before they proceed with the content knowledge of Form Four nutrition.

Therefore, this study aims to study Form Four Biology students' drawing and misconceptions before they are taught of the topic of nutrition at secondary schools in Kuching District, Sarawak.

1.3 Objectives

1.3.1 General objective

To investigate Form Four Biology students' drawings and misconceptions about human digestive system at two secondary schools in Kuching District, Malaysia.

1.3.2 Specific objectives

i. To establish the kind of drawings of the human digestive system that is generated by Form Four Biology students.
ii. To determine Form Four Biology students’ explanation concerning human digestive system based on their drawing.

iii. To determine Form Four Biology students’ misconceptions of human digestive system as generated from their drawing.

iv. To investigate Form Four Biology students’ misconceptions of human digestive system as generated by questionnaire.

1.4 Research Questions

1.4.1 General research question

What are Form Four Biology students’ drawings and misconceptions about human digestive system at two secondary schools in Kuching District, Malaysia?

1.4.1 Specific research questions

i. What kind of drawings of the human digestive system that is generated by Form Four Biology students?

ii. How is Form Four Biology students’ explanation concerning human digestive system based on their drawing?

iii. What are Form Four Biology students’ misconceptions of human digestive system as generated from their drawing?

iv. What are Form Four Biology students’ misconceptions of human digestive system as generated by questionnaire?
1.5 Theoretical Framework

The objectives in this study are related to misconceptions, drawing and ideas. Therefore, the knowledge in the mind is investigated using drawing and verbalization. Knowledge in the mind is in line with studies of Piaget and the theories related to cognitive constructivism framework.

Objective 1
Drawing of human digestive system

Objective 2
Explanation of human digestive system based on drawing

Objective 3
Misconceptions of human digestive system as generated by drawing

Objective 4
Misconceptions of human digestive system as generated by questionnaire

Knowledge in the mind

Form Four Biology students' drawing and misconceptions of human digestive system

Figure 1.1. Theoretical framework of study.

1.6 Significance of the Study

This study will reveal the understanding of students about the human digestive system, which can help in further learning of the topic in Form Four Biology. Misconceptions of students in the topic can also be identified, assisting teachers to design lesson plan based on student's misconceptions of human
digestive system to promote better understanding on biology topics. An alternative method besides written test that is drawing with description can be used to identify students' misconceptions by teacher. Curriculum developers can plan the biology syllabus by considering students' misconceptions. Furthermore, parents can be better exposed about their children's misconceptions and can provide proper guidance to them in daily life. The instrument used in this study can be used as a guideline for other researchers in Malaysia who are interested in student's drawing and misconceptions of human digestive system as it is built based on Malaysia's Biology curriculum.

1.7 Limitations of the Study

Only ten samples are used in this study, which cannot be used to generalize to the entire population of Kuching Form Four Biology students. The source of misconceptions investigated in this study is excludes the teaching instruction and misconceptions of teacher. This study focused on misconception that may arise from the learner's understanding. Gender and school issues are not considered in this study.

1.8 Definitions of Terms

1.8.1 Misconception

Conceptual Definition

Alternative, original and preconcepts are terms used to describe the ideas that are developed before encountering the knowledge of related subject. These preconcepts are not classified as wrong although it is different from the knowledge
that is known. Occurrence of preconcepts at the beginning stages of scientific learning in Biology is common. School-made misconceptions that are due to inappropriate teaching methods and materials can be avoided unlike preconcepts, by using suitable teaching methods and updated the teachers with the changes in the content knowledge of the subject (Barke, Hazari, & Yitbarek, 2009).

**Operational definition**

In this study, misconception refers to any ideas of learners that are conflicted with the generally accepted scientific knowledge (Tekkaya, 2002). These misconceptions may be preconceptions or school-made misconceptions.

1.8.2 Human digestive system

**Conceptual definition**

The study of Cakici (2005) only focused on digestion of food instead of the organs that are involved in the digestion process. Food digestion is considered from the aspect of chemical digestion only. The chewing of food or physical break down of food in mouth and stomach is excluded from food digestion. Choo and Low (2008) stated that digestion is the process of breaking down food molecules into smaller molecules that can be readily absorbed by the body. Digestion is divided into physical and chemical digestion. Physical digestion involved chewing by the teeth and churning of the food in the stomach. Meanwhile, chemical digestion involves the action of enzymes on food (Choo & Low, 2008).
Operational definition

Human digestive system in this study is based on the content of Form Two Science textbook (Appendix A) by Choo and Low (2008) which involves the aspects of anatomical of human digestive system and digestion. The organs and structures including accessory organs such as liver, pancreas and bile are included in the content of human digestive system. Besides that, human digestive system also includes content knowledge such as, the passage of food through the digestive tract.

1.8.3 Drawing

Conceptual definition

Drawing in biology is used to describe an object in the lab, anatomical and microscopic studies. Drawing requires careful observation and interpretation of the nature. Techniques involved in drawing include describe, observe, study surface design, draw exterior and interior lines, and to see and record spaces rather than objects (Dempsey & Betz, 2001).

Operational definition

The drawing of student on human digestive system in this study requires student to recall and express their understanding on the anatomical of human digestive system. The source of the original observation on human digestive system is not restricted.