



DEVELOPMENT OF A CONCEPTUAL INVENTORY ON HUMAN SKELETAL SYSTEM CONCEPT

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Introduction & LR

Students have a number of explanations related with human body systems. These explanations differ from accepted scientific concepts and they generally named as misconceptions or alternative conceptions. Several studies explored children's misconceptions about the human body (Mann, M. & Treagust, D. F., 1998; Tunnicliffe & Reiss; 1999; Jaakkola & Slaughter, 2002). Researchers use various techniques to assess students' misconceptions such as interviews, open-ended questions and drawings. One of the powerful methods to investigate misconceptions is conceptual inventories.

Conceptual inventories use common misconceptions as the distracters. In this format, as well as for assessment, they also be used to identify student misconceptions to shape better learning activities that provides deeper understanding of the concepts in a constructivist class environment (Mercer, 2008; Battisti et al, 2010). According to Evans and colleagues (2003) such assessment inventories play an important role in relating teaching techniques to student learning.

There are specific characteristics that differ conceptual inventories from regular multiple choice tests.:

- The development of the conceptual inventories relies on an extensive research.
- The incorrect answers known as distracters of items are common misconceptions held by students.
- Distracters are written in student's language and derived from students' own words.
- Conceptual inventories assess students if they can select the correct concept among the common misconceptions as well as if they understand the concept correctly.

Although there are various conceptual inventories on biological concepts, they are substantially more relevant with older students. Furthermore, students' misconceptions on the Skeletal and Muscular Systems (SMS) were not investigated as well as other human body systems.

The Purpose of the Study:

The aim of this study is to develop a qualitative instrument to assess students' misconceptions in Human Skeletal and Muscular Systems (SMS). Moreover, this study provides information about student misconceptions on SMS and points out the important concepts through the related subject.

Participants:

Participants of the study were students from elementary school in the district of Ankara in Turkey. Pilot study was conducted to 66 7th grade students, age ranging from 13 to 15. After the pilot study, the test implemented to 179 6th grade students age ranging from 12 to 14. All the students were from middle class families.

The Conceptual Inventory

The CI focuses on the essential ideas of SMS. It is a 10-item multiple-choice test designed specifically for junior level science courses. Each of the items has a scientifically accepted correct answer and three common misconceptions worded in the language that the students use to express the concepts. Additionally, each item has a fifth choice as 'I have no idea about this question.' to select students without any prior knowledge on the concept of the item and to avoid the missing items in addition to answering by guess. After each items, the inventory asks to students their confidentiality for their answers with a yes/no question to be able to distinguish students with deep misconceptions or students who select the right item by guess. Each item counts as correct if the students are able to pick up the correct answer and choose yes for their confidentiality. Hasan, Bagayoko and Kelley (1999) suggested that high certainty on a incorrect answer is an indicator of a deep misconception on students. On the other hand, low certainty indicates lack of knowledge and correct answer with low confidence may display responding by guessing.

Development Process



ITEM EXAMPLE

1) Four students make statements about if the bones on their body are alive or dead. Which of the following is true?

- 1st Student: Bones are alive. Because they can move.
- 2nd Student: Bones are alive. Because they are composed of alive cells.
- 3rd Student: Bones are dead. Because they cannot move themselves if we do not move them.
- 4th Student: Bones are dead. But the vessels inside of them are alive.
- I have no idea about this question.

1a. Are you confident about your answer for this question?

- Yes
- No

Results

Validity and Reliability

Three experienced elementary science teachers, two professors on the major of elementary science education and a medical doctor who expert on human body systems evaluated the items for their appropriateness, correctness and understandability for intended age. They suggested minor revisions for items.

For reliability analysis a pilot study was conducted and alpha coefficient was found as .57. Two items were revised based on the student data derived. The last version of the test implemented to students mentioned on the sample part and the obtained reliability coefficient was .62.

Item Difficulty and Discrimination:

Item No	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10
Difficulty Level	0.50	0.23	0.24	0.27	0.25	0.48	0.53	0.43	0.38	0.28
Item Discrm.	0,06	0,02	0,11	0,25	0	0,13	0,17	0,04	0,15	0,23

Sample of Descriptive Analysis on Misconceptions Bones are death or alive?

54% of students responded correctly to the first item and rest of the students think that eighter bones are death or explained that they are alive since they can move.

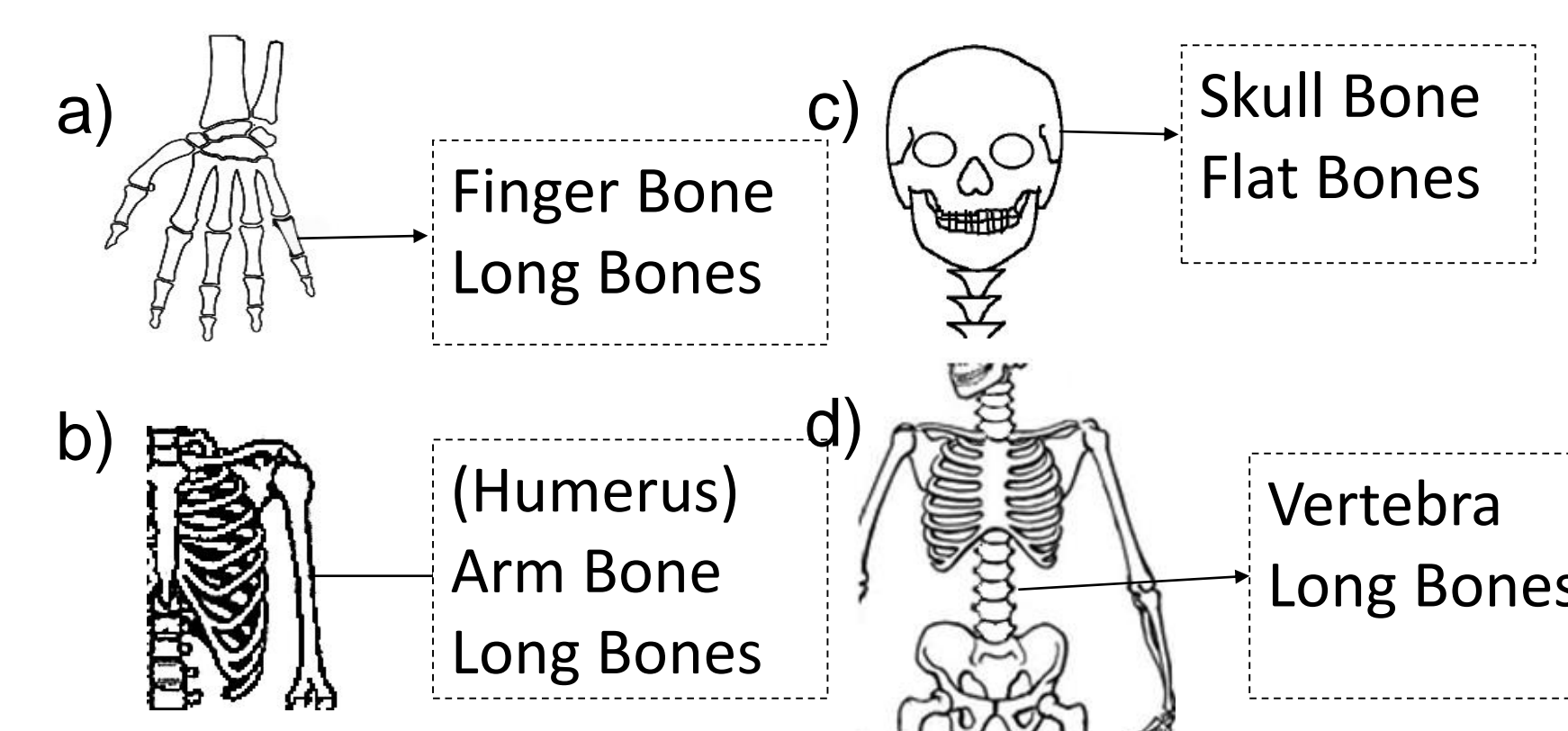
Types of Bones and Joints

The answers of the students to questions 6 and 8 shows that students have confusion about the classification of bones and joints..

Moreover, question 6 presents four examples of bones types and asks the wrong matching. Most of the students selected the right answer (54.5%). For this question choice A is a fairly strong distracter. The part of the explanation is that 31.8% of the students think finger bones are short bones since they are shorter than long bones.

ITEM EXAMPLE

6) The teacher asks students to show examples to different types of the bones. Which student shows a **wrong** example for the mentioned type of the bone?



e) I have no idea about this question.

6a. Are you confident about your answer for this question?

- Yes
- No

Lastly, question 8 assesses students' explanation on the reason that fingers can move more than the neck. Half of the students chose the correct response while others have misconceptions like having more joints or thinner bones in the fingers and vital vessels on the neck.

The Function of Skeletal System.

Questions 3 and 4 aim to measure students' understanding of function of skeletal system. 68.2% of students think that blood vessels spread the body through bones and high amount of students incorrectly think that (38.1%) bones are not responsible on the production of red blood cells while only 31.3% of them correctly choose they are not responsible on sense of touch

What about Muscles and Muscle Types?

Questions 5 and 9 deal with the function of muscles and their types. The amount of students who accepts that some muscles helps to breathe was 35.2% while others have alternative explanations like protecting bones, producing blood cells and providing gas exchange. Question 9 asks the reason of controlling the movement of arms and legs, although not controlling the movement of internal organs. 46% of students choose the explanation through the muscle types while others hold misconceptions about general human body.

Conclusions

Despite a growing body of research in students' misconceptions toward human body systems, comparatively little attention has been directed on the concept of Skeletal and Muscular system. The results of the analyses show that elementary students held lots of misconceptions and this conceptual inventory is a valid and reliable inventory to assess them. Actually, the reliability coefficient of the test was lower than the expected. At this point, it is important to explain that the reliability coefficient is tolerable for educational studies although it is low in some degree (Diakidoy, Kendeou, & Ioannides, 2003; Hatcher & Stepanski, 1994; Pinarbasi, Canpolat, Bayrakceken, & Geban, 2006; Pomeroy, 1993). It is possible to improve reliability by adding new questions or asking multiple questions on same subjects but it would increase the length of the test and the required time for students. Moreover, necessity of misconceptions for developing items and limitation of the subject on elementary school level complicate to add new questions. Moreover, as shown in the table the discrimination scores of items are quite low and item3 has a negative score. Considering that this test is not a regular achievement test that assesses knowledge, we can explain this low scores as upper and lower students may have same misconceptions reflected on the items. Overall the study shows that this inventory can be an effective tool for teachers who want to raise their awareness of students' misconceptions before and after instruction as well as researchers who aim to identify and classify students' misconceptions. It is also a valuable measurement to evaluate the instruction or validate the effectiveness of the new methodologies generated for deep conceptual understanding.