The use of drawing as an alternative assessment tool in biology teaching

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Abstract. Science required the recording of data to build knowledge. The act of drawing an illustration is one of the oldest methods to record the data in science. Illustration in science provides information that the written word cannot, hence the old adage “A picture is worth a thousand words” is very important for studying science. Drawings an illustration is not only valuable for artists but also for scientists because some aspects of science process skills can also be developed through drawing. In terms of science teaching, applying the act of drawing can also be used as an assessment tool. In this study, we assessed drawing of human internal organs of 38 student teachers who enrolled human physiology course and its correlation to their final exam achievement. Guidance of biological drawing was employed to assess the quality, labelling, and annotations of the drawing. The finding of this study showed that there was a positive correlation between the quality of drawing and final exam achievement. It is suggested that using the method of drawing in combination with written responses assessment would provide a more complete information about student’s understanding of human internal organs.

1. Introduction
The act of drawing an illustration is one of the oldest methods to record the data in science. Drawings an illustration is not only valuable for artists but also for scientists because some aspects of science process skills can also be developed through drawing [1]. Drawing is a common learning activity that is always be done by students in school. In biology lesson, drawing mostly used to record observation data such as organism’s cells, tissues, organs and organism specimens. Drawing has also become an important tool for many educational researchers to access student’s understanding of the specific biological concepts. The researchers use student’s draw to reveal student understanding about cell divisions [2], system organs [3,4], and digestive system [5]. Students can express a wide range of ideas through drawings [6]. This is different to what is provided by standard written texts, where students recall what they learned in class without revealing their understanding.

A study investigating conceptual understanding through drawing involving 116 student teachers in one of the university in Turkey revealed that 50.9 % of the student teachers have partial drawing (partial understanding) of human digestive system and only 19.8% performed full understanding [6]. Another study also found that students have lack of understanding of organ systems from their school biology. This study found that most of the students knew about the organ but unable to make a comprehensive linkage of the organ systems, for example the student knows about bones but unable to draw skeletal systems [7].
The knowledge about location, shape and function of human internal organs has been widely investigated by many researchers [2-8]. The study found that more than 50% of the students get problems to draw a shape and correct location of the human internal organs. Another studies found that eight years students had a broad knowledge about their internal organs and they had a weak understanding of how organs work as organ systems [7,8]. In terms of gender, research has found that gender has no significant difference on student’s understanding but male and female students has significant difference on how they represented their reproductive organs [7]. In regard to those studies, it is important to assess student teachers’ understanding about human internal organs to make sure that they have a proper understanding for their future carrier as science teachers.

Student teacher’s knowledge about the human internal organs was assessed in this study. It focuses on the correlation between student’s internal organs drawing and their knowledge about these organs; and also the use of the drawings result as assessment tool of student teacher’s understanding.

2. Methods
A total of 38 science student teachers who enrolled human physiology course were participated in this study. All of the participated students were third year student in one university in Bandung. The majority of the students were female (34 female students and 4 male students). Thus, the study was not focusing on gender differences. The study was conducted in a regular semester class of human physiology course. The course consisted of 11 different organ systems. These include integumentary, muscular, skeletal, nervous, circulatory, lymphatic, respiratory, endocrine, urinary/excretory, reproductive and digestive system. At the end of each organ system, the student’s understanding of the organ systems was assessed using written test (multiple choice and short essay) and their drawing of each organs system. To draw the internal organ systems the students were provided 15 minutes to complete their drawing, name and write the functions. After the drawings had been collected, the drawings then sorted and ranked them in order based on the level of student’s biological understanding. The leveling for the student’s understanding consists of 7 levels adapted from previous study [7]. The leveling criteria can be seen in Table 1.

Table 1. The system used to score the biological quality of each drawing

| Level  | Criteria |
|--------|----------|
| Level 1 | No representation of internal structure |
| Level 2 | Internal organs placed at random |
| Level 3 | Internal organ in inappropriate position, less proportional and incomplete as an organ system |
| Level 4 | Internal organ in appropriate position, less proportional but incomplete as an organ system |
| Level 5 | Internal organ in appropriate position, less proportional but complete as an organ system |
| Level 6 | Internal organ in appropriate position, proportional, complete as an organ system but missing specific details |
| Level 7 | Comprehensive representation of human internal organs |

3. Results and Discussion
The results were grouped according to presence or absence of internal organs, proportion, location and function of the drawn of the organs system.
3.1. Location, proportion, completeness of the organs in the student’s drawing.

Table 2. Percentage of student’s drawing level.

| No | Level | Percentage |
|----|-------|------------|
| 1. | Level 1 | 0%         |
| 2. | Level 2 | 0%         |
| 3. | Level 3 | 0%         |
| 4. | Level 4 | 21.05%     |
| 5. | Level 5 | 39.47%     |
| 6. | Level 6 | 28.95%     |
| 7. | Level 7 | 10.53%     |

Table 2 shows that there was no student who fell in level 1 until level 3. Most of the student drawing were in level 5 (39.47%), followed by level 6 (28.95%), level 7 (10.53%) and level 4 (21.05%). Student teacher’s drawings in level 5 were able to perform internal organ in appropriate position, less proportional but complete as an organ system. One of the example was the oval shape of the lung inside chest cavity. Student teacher’s drawing in level 6, they were able to perform internal organ in appropriate position, proportional, complete as an organ system but missing specific details such as right and left lung performed without the number of lobes. Student teacher’s drawing in level 7 showed a comprehensive representation of human internal organs. Last, student teacher’s drawing in level 4 were unable able to show Internal organ in appropriate position, less proportional but incomplete as an organ system.

The finding consistent with the previous study, as one expects that older student attain higher level of understanding of the internal organs [7]. It is because they had their understanding from previous school experiences and also at the same time they were registered in human physiology course. Therefore, the issues that arise relate only to the accuracy of position of the organ, the proportions and the specific details only. All of the students realized that organs are situated in specific locations, joined together as a functional unit as a whole organ system.

3.2. Correlation between written test achievements and student’s drawing levels

The data of written test score and drawing level are presented on Table 3. The highest score of written test was 86 and the least was 63. In terms of drawing level, the level was ranging from 4 to 7. No student showed level 0 until 3 in their drawing. The written test score and drawing level data was further analysed to reveal their relationship in order to reveal whether drawing can be used as alternative assessment for student content’s comprehension of human internal organs.

Table 3. Data of student’s written score and drawing level

| Student   | Written Test Score | Drawing Levels |
|-----------|--------------------|---------------|
| Student 1 | 86                 | 7             |
| Student 2 | 85                 | 7             |
| Student 3 | 84                 | 7             |
| Student 4 | 83                 | 7             |
| Student 5 | 80                 | 6             |
| Student 6 | 79                 | 6             |
| Student 7 | 79                 | 6             |
| Student 8 | 78                 | 6             |
| Student 9 | 78                 | 6             |
| Student 10| 76                 | 6             |
| Student 11| 76                 | 6             |
The relationship between written test final scores and drawing levels was investigated using Pearson product-moment correlation. Table 4 shows that there was a strong, positive correlation between written test final scores and drawing levels, $r = 0.76$, $n=38$, $p < 0.05$.

### Table 4. Correlation between written test final scores and drawing levels of the students.

| Variables | Written Test | Drawing |
|-----------|--------------|---------|
| Written Test | - | 0.76 |
| Drawing | - | - |

This finding consistent with previous study, study showed that there was a strong, positive correlation between written test score and drawing [7]. The score of written test represents student teacher’s understanding of the contents. This finding showed that student teacher’s understanding has a consistent statement with their internal organ system drawing. Different result has been revealed that student’s understanding was inconsistent [3]. The inconsistent result in that study was because the sample come from various school background that increase the different level of understanding.

The positive strong correlation between those variables can be seen from the trends of student’ score and level. The student with high written test has also high level of internal organ drawing while the students with lower score showing lower level of drawing. The drawing in this case was not how artistic the drawing but it is all about the details of the organs and the precision of organs location inside human body.

Using drawings as an alternative assessment of the human body is effective to reveal students’ concepts of size, shape, and location of internal organs [3]. In daily teaching practices, using both written
test and drawing would provide more complete information about student’s understanding because through drawing students can express their understanding. This combination also helps to motivate students to have joyful variety of their assessment, that is different from their standard written test.

But, using the drawing as assessment tool also raises several limitations. First, the time to draw is limited, hence student certain location, proportion and specific details would be difficult to be drawn or performed in a short period of time. Second, some of the students have limitation of their own drawing skills, therefore they could not show the organs properly. And last, organ dimension made the drawing become more difficult to draw.

4. Conclusion
From the study, it can be concluded that student teacher’s as the older students attained high level of understanding of their internal organ through internal organ drawing. The strong positive correlation between written test score and drawing levels suggest that using the method of drawing in combination with written responses assessment would provide more complete information about student’s understanding of human internal organs.

5. References
[1] Quillin K and Thomas S 2015 Drawing-to-learn: A framework for using drawings to promote model-based reasoning in biology CBE-Life Sciences Education 14 1–16
[2] Dikmenli M 2010 Misconceptions of cell division held by student teachers in biology : A drawing analysis Scientific Research and Essays 5 235–247
[3] Prokop P and Fančovičová J 2006 Students’ ideas about the human body: Do they really draw what they know? J. Balt. Sci. 2 86–95
[4] Öskarsdóttir G, Stougaard B, Fleischer A, Jeronen E, Lützen F and Kråkenes R 2011 Children’s ideas about the human body–A Nordic case study Nordic Studies in Science Education, 7 2 179-189
[5] Ören F Ş 2011 An analysis of pre-service teachers’ drawings about the digestive system in terms of their gender, grade levels, and opinions about the method and subject International Journal of Biology Education 1 1 1–22
[6] Cardak O 2015 Student science teachers’ ideas of the digestive system Journal of Education, and Training. Studies 3 127–133
[7] Reiss M J and Tunnicliffe S D 2001 Students’ understandings of human organs and organ systems Research in Science Education 31 383–399
[8] Özsevgeç L C 2007 What do turkish students at different ages know about their internal body parts both visually and verbally ? Journal Turkish Science Education 4 31–44