Computer assisted instruction (CAI)-based learning: instructional need for pupils’ conceptual understanding of water cycle?

S Nurlaili and D R Sari

Department of Primary Education, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia

*Corresponding author’s email: shofiyatun.nurlaili@upi.edu

Abstract. This study is aimed to identify the Computer Assisted Instruction (CAI) based on learning as an instructional need for students’ conceptual understanding about water cycle. Qualitative descriptive method was used in this study. The data collection used mini interviews and test. Participants were three students average 11-13 years old from different schools. The multimedia-based CAI application used by the researcher to understand pupils’ conceptual understanding of the water cycle is implemented on laptops or desktop computers used Windows operating system. The result showed that pupils’ conceptual understanding of the water cycle are still lack and have many misconceptions can be seen from the results of students’ test when drew water cycle. The sustainable development will be achieved if the instructional needs through improvement of CAI are fulfilled.

1. Introduction

The operational concrete stage is called by Piaget for children on 7 to 11 or 12 years old. At this stage, the students’ cognitive development have an organized thinking process to a larger system of mental processes that make it easier for them to think more logically [1]. They need the conceptual understanding as the initial basis in formulating their knowledge. The concept is a conclusion from an understanding consisted of two or more facts that have the same characteristics [2]. A conceptual understanding based learning is instructional needs in the real context found in the surrounding environment. It can develop students’ critical thinking skills, improve conceptual understanding and avoid misconceptions. As revealed by Sands [3] that the misconception must be replaced with a correct concept. Furthermore, the conveying through language is also very important because of the concept of one's thinking [4].

Conceptual understanding is taught for students because it has several benefits including 1) Concepts make us need to repeat the search for meaning, every time we find new information 2) Concepts can help the process of remembering and make it more efficient 3) Concepts help we simplify and summarize information, communication and time used to understand that information 4) Concepts are the basis for higher mental processes 5) Concepts are indispensable for problem-solving 6) Concepts determine what someone knows or believes [5].

One of the conceptual understandings that important to apply to the concrete operations stage is the conceptual of water cycle but it often has potential misconceptions among students and adults alike. Their conceptual understanding is only about characteristics of the water. They think that the water cycle only
focus on freezing and thawing. Many students especially in elementary school are still difficult to conserve material about evaporation, condensation so that the concept is difficult for them to understand [6]. In fact, recently there are still some misconceptions, especially regarding ecology and the environment, related to water cycle material whereas his material is very important in terms of constructivist perspective so that students have meaningful knowledge about ecological and environmental concepts [7].

It shows that the conceptual understandings about the water cycle which are implemented in several schools have not been optimal. One of the causes is the lacking instructional need that used for teaching and learning. The instructional need for teaching and learning by Information and Communication Technology has developed rapidly delivered through visual aids. Students more understand about the subject through what they see and hear from computers or televisions because they also support instructional materials with different sounds, images and simulations, tend to encourage more lasting, pleasurable and effective learning [8].

In this study, the researcher used information and technology-based learning for instructional need contains text, sound and video by CAI (Computer Assisted Instruction). CAI is the development of integrated information technology that supports each other. The content of CAI includes animation, images, audio, video and interactive communications are packaged based on multimedia [9]. The next question is CAI can become the instructional need for teaching and learning especially for pupils’ conceptual understanding of water cycle or not. The aim of the research is to identify that the CAI as an instructional need for pupils’ conceptual understanding of water cycle.

2. Methods

This study used descriptive qualitative research. It is a method of research that describes the phenomena recently or in the past to help readers know what is happening in the field [10, 11]. This study used descriptive research from the data in the form of words. This type of research was used to describe, understand, and explain the conceptual understanding by CAI (Computer-Assisted Instruction). The research instruments used mini interviews and tests about the water cycle. Students’ tests are multiple choices from CAI and draw test. Participants were three students at Bandung City who were 11-13 years old (the initials’ names are BN, SV and AD). In this case, the researcher only used three participants to analyze more deeply about the students’ conceptual understanding from the different schools. There are several CAI models offered as learning media [12], there are:

1. Explanation (Tutorial). The tutorial aims to convey or explain certain subject matter, where the computer delivers subject matter, asks questions and provides feedback according to the students' answers.
2. Drill and Practice. Drill and practice can be applied to students who have learned the concept (basic ability) with the aim of strengthening the concept that has been learned, where students are ready to recall or apply the knowledge they already have.
3. Simulation. Simulation is used to demonstrate something (skill) so students feel like they are in a real state. Simulation is widely used in learning subject matter that is dangerous, difficult, or requires high costs, for example, to train aircraft pilots or fighter planes.
4. Games. This type of games is appropriate if applied to students who like to play. In fact, if it is well designed as a means of playing and learning, it will further enhance student learning motivation.

In this study the researcher used Tutorial, Drill and Practice to determine the understanding of students' concepts about water cycle. Tutorial can help students to get explanation about the subject matter and provides feedback according to the students' answers whereas drill and practice can help students to give exercises to recall the knowledge already they have. In this case, the CAI used Power-point application to show content. The power point is considered to have features that are easier to use and understand for beginners who using CAI.

Computer Assisted Instruction (CAI) is the process of written and visual information that is presented in a logical sequence to a learner through a computer. The students read the text of subject matter that presented or observed by the graphics information and it displayed used some of the audio and video content
presentations [13]. In this study, the researcher modify and even produce CAI material based on the needs of conceptual understanding of water cycle by Microsoft Power point. It has several slides and the contents are text, videos, images, animations and sounds that are implemented on laptops or desktop computers with the Windows operating system.

This CAI made by the researcher contained 12 slides related to water cycle. On the slide 1, displays the title of the material about the water cycle; slide 2 contains text, animation and sound recordings that explain the water cycle that is integrated with the learning video on the next slide; slide 3 displays a piece of learning video. This video is downloaded from you tube which explains the water cycle and some explanatory information about water cycle’s steps. The steps of the water cycle are evaporation, condensation, precipitation and transpiration to help provide an initial understanding of students' concepts of terms in the water cycle.; slide 4 and the next shows the lesson menu that containing the conceptual understanding of the water cycle; slides 10 and 11 contain exercises by multiple choices, If the student chooses the answer correctly, an animated image of "the woman who gave the thumb" appears and there is the word "Right" but if the answer is wrong it will show a picture of "woman who cries" and there is the word "False". With this enrichment, it is very helpful for students in re-understanding the concept or material that has been delivered on previous slides; slide 12, contains instructions for drawing a water cycle on paper provided by the researcher. For this activity, the researcher chose to give test for students by the paper test through drawing water cycle. It can make students easier to understanding the conceptual learning of the water cycle. Thomas and Silk on [7] also explained that while children drawings provide a window into their thoughts and feelings, mainly that they reflect the image of his or her mind.

3. Result and Discussion

3.1. Result

The result of this study shows that students' conceptual understanding of water cycle is still lack and many misconceptions. It can be seen from the results of students’ paper test when drawing water cycles. They still did not understand about the term of evaporation, condensation, and precipitation which was used to use video on the CAI so that they had difficulty to write the steps and arrows of water cycle. After the students watch the video about water cycle, they see the next slides about the lesson menu that containing the conceptual understanding of the water cycle. It can help the students to understand about evaporation, condensation and precipitation but the results that knowledge of students related with the water cycle is limited. The results evidence of three students can be seen in the following figures.

![Figure 1. BN’s Drawing Test (11 years old)](image)

Figure 1, shows the result of BN's test when drawing a water cycle. The BN’s conceptual understanding of the water cycle has several misconceptions, including: at the evaporation stage there is a picture of the sun covered in dark clouds when illuminating the sea surface and evaporation occurs. Furthermore, dark
clouds turn into bright colors and condensation occurs, the clouds also release water dots. In the next stage there is rain called precipitation. Rainwater flows into the mountains and the sea and then evaporates again. In addition, BN wrote the wrong term because he wrote evaluation was not evaporation. The statements of BN by his drawing test are scientifically is still not correct. BN still confuse about the steps of water cycle. After that, the researcher confirms BN's answer by a mini interview. It turned out that students' conceptual understanding was still lacking because BN actually understood the stages of the water cycle but when he placed the term evaporation, condensation, and precipitation, he was still hesitant and had difficulty mentioning the term because the video explanation was too fast for him.

**Figure 2** SV’s Drawing Test (average 12 years old)

Figure 2, shows the result of SV when drawing a water cycle. SV’s conceptual understanding of the water cycle, starting with the evaporation process. The evaporation process is two different steps, namely the evaporation of seawater due to the sun's rays and the evaporation of the mountain and then a bright cloud is formed. The bright clouds then change color to dark clouds and a condensation process occurs. However, in the direction of the arrow used there is a misconception because there is a direction of arrows from two sides, causing ambiguity for bright clouds turn into dark clouds and dark clouds can to turn into bright clouds in the process of condensation. The statements of SV by his drawing test are scientifically is still not correct. After the condensation process dark clouds emit water points called rain (precipitation). In the precipitation process, the image of the arrow also points in two directions, this causes ambiguity because the precipitation process occurs from two opposite directions. Then the rainwater falls to the surface of the earth (mountain). SV also wrote the word "transpiration" but the placement of the writing was not appropriate and caused a misconception because transpiration is evaporation that occurs in plants or living things. The researcher confirms SV’s answer used a mini interview. It turned out that the students' conceptual understanding was still lacking when determining the direction of the cycle of arrows and he also had difficulty in determining the stages of the water cycle in accordance.

**Figure 3** AD’s Drawing Test (average 12 years old)
Figure 3, shows the result of AD when drawing a water cycle. AD’s Conceptual understanding about the water cycle begins with the process of evaporation by seawater to form clouds because it gets sunlight. Then the picture also shows a misconception because after that the cloud experiences a process of condensation, and takes out water points and when the precipitation process also describes the water points down to the surface of the earth and flows into the sea. The AD’s image also shows less arrow direction which indicates the occurrence of a water cycle. Next, the researcher conduct mini interview to him. It turned out that students' conceptual understanding seemed very lacking because he still did not understand the term of evaporation, condensation, and precipitation which was used to use video on CAI so that they had difficulty to write terms and arrows. In fact, when the researcher tried to do the interview he was hesitant to answer it and seemed to not understand it.

3.2. Discussion
The students’ drawing tests show that they still do not understand the concept of the water cycle correctly. They are still having difficulty distinguishing between the terms evaporation, condensation, precipitation and transpiration and where the process takes place. Although some students can answer the multiple choices by CAI as well, apparently it is not guarantee that their conceptual understanding was correct. When the researcher asked them to draw of the water cycle, the researcher found many misconceptions. Therefore, the conceptual understanding of water cycle must be taught early, especially in elementary school ages as the initial basis for understanding the concept of their knowledge. If it is not well understood by students, this misconception will continue into adulthood. Majority of studies are held on the understanding of science and their misconception because the misconception is one of the significant factors which affect learning. Misconception implies thinking patterns which do not overlap with scientific realities with an general meaning, rather contradicted with them being developed in their minds [5, 7]. The misconceptions also often occur in learning related to ecology and the environment [7]. One of the learning materials that is often found to be misconceptions is material about the water cycle.

The misconception that occurred was not only due to the results of the students' work but also from the CAI delivered, it turned out that the CAI's contents used too much text while for content containing video or sound was still limited. The video showed also has not explained the complete information contained in the material so the CAI only helps students understand the water cycle separately not thoroughly along with the direction of the arrows at the stages in the cycle. Therefore, the CAI that used must be renewed and be adapted for students through text, sound or video by using Software named Adobe Flash. In the other hand Adobe Illustrator CS6 and Photoshop CS can be used for creation and decoration. Not only the students enjoy with the CAI, but they also can hear the pronunciation or how to speak steps in the water cycle correctly. An informative education should be given to teachers about the properties of CAI, computers and the use of computers in order to make use of CAI well. It is not possible to make CAI successful with teachers not having plentiful knowledge about computers and CAI [14].

4. Conclusion
Students' conceptual understandings regarding the water cycle still lack and have misconceptions. It can be seen from the results of students’ paper test when drawing a water cycle. The use of CAI in learning is only able to help students understand the subject matter of water cycle separately through multiple choice questions. However, at the drawing test it was seen that the students' conceptual understanding was still lacking, for example: when draw the direction of the arrow and the terms of the stages water cycle (evaporation, condensation, precipitation, and transpiration). The existence of misconceptions continuously can be avoid and reduce by improving the content and display on CAI that give the informative education so that the material is well conveyed and students are able to comprehend concepts thoroughly and deeply especially about water cycle.
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