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Using different conceptual change methods embedded within 5E model: A sample teaching of liquid pressure

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Received: 18 February 2009; accepted: 20 April 2009

Abstract

Since teachers have a busy schedule, several studies show that teachers have difficulty in incorporating students' pre-existing knowledge in their courses. For this reason, to get teachers to comprehend how to incorporate students' pre-existing knowledge in their courses, sample teaching design should be illustrated. The aim of this study is to illustrate a 5E model on incorporating in students' pre-existing knowledge using computer simulations, analogy and worksheet based on the assumption that using different learning methods together may be more effective in eliminating students' misconceptions completely. Because the study is a hypothetical paper, to investigate applicability of presented teaching design, further research should be undertaken.

Keywords: Constructivism; 5E model; Worksheet; Computer simulation; Analogy; Liquid pressure; Misconception

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1. Introduction

Since early 1990s, the constructivist view of learning which defends that students can actively acquire new knowledge based on their pre-existing knowledge rather than knowledge transmitting from teacher to students, has influenced science curriculum thinking [1-2]. In other words, students' pre-existing knowledge is very important for further learning [1, 3]. As a matter of fact, to solicit student's pre-existing knowledge, much research has been carried out in different perspectives such as force and motion [4-7], light [8-10], heat and temperature [11-13], air pressure and gas pressure [14-16], liquid pressure [17-19] and photosynthesis [20-23].

In core of the present study, since pressure is one of the most important topics that students encountered their daily life [17, 19], related studies has pointed out that students' learning difficulties of '*pressure*' concept may result from their pre-existing knowledge [19] or daily life experiences and course textbooks [17] or confusing concepts with each other (using interchangeable) [24] and a lack of visualizing phenomena at sub-microscopic [25]. What alternative conceptions students held on liquid pressure is as follows: 'liquid pressure has a direction', 'liquid pressure depends on the amount of liquid or container's shape', 'liquid pressure is calculated by means of related surface', 'to calculate liquid pressure, related surface is taken into account', 'liquid pressure is divided or shared', 'pressure is seen as either an object or a matter', 'liquid pressure is a property of the liquid' [17-19, 25-26]. Unfortunately, since teachers have a busy schedule, several studies show that teachers have difficulty in incorporating students' pre-existing knowledge in their courses [3, 27-30]. For this reason, to get teachers to comprehend how to incorporate students' pre-

existing knowledge in their courses, sample teaching design should be illustrated.

To achieve conceptual change and have a more sophisticated learning, much research has attempted to implement different conceptual change techniques such as animation/analogy [18, 31], storyline design within constructivist learning model [19] and discovery learning [25]. But they addressed that their used techniques failed to overcome completely students' misconceptions of 'liquid pressure'. Thus, it is supposed that using different learning methods together may be more effective in eliminating them completely [32-34].

The aim of this study is to illustrate a 5E model on incorporating in students' pre-existing knowledge using computer simulations, analogy and worksheet.

2. Theoretical framework

What each 'E' means is explained as follows: (1) *engagement/enter* where teacher engages students in a new concept using short activities or questions, thus, students' pre-existing knowledge is activated, (2) *exploration* where to generate new ideas students not only carried out activities such as lab activities, group discussion, hands-on activities but also conduct a preliminary investigation by means of their own pre-existing knowledge, (3) *explanation* which is the most teacher-centered phase in 5E model. Teacher directly introduce a concept, process, or skill so that (s)he confirms/disconfirms students' experienced knowledge claims, (4) *elaboration* where students try to expand their newly acquired knowledge to a deeper and broader understanding to laborate their conceptual understanding and skills, (5) *evaluation* where

teacher can track student's progression in terms of educational objectives. [35-37].

3. Teaching design

Now we will illustrate how to adjust the associated conceptual change methods within 5E model (Engagement/Enter, Exploration, Explanation, Elaboration and Evaluation).

3.1. Engagement/Enter

Students are divided into small groups of 3-4 students before worksheet is handed out. To increase students' awareness of liquid pressure and activate their pre-existing ideas, students watch figures of 'dam set' from surface to bottom in a thickened manner (Fig. 1).



Fig. 1. Different dam sets.

Then, students are asked to read story at the top of the worksheet. The question ‘In your opinion, why Yamula Dam set is getting thick from surface to bottom?’ is directed. The story is presented in the following:

“Hasan and his family made a grill party in near Yamula Dam built on ‘Kızılırmak’ river. While Hasan was exploring outskirts of Yamula Dam, he noticed that its set is getting thick from surface to bottom. However, he did not explain this situation with his existing knowledge

Exploration: In this step, students implement the related activities in their small group by means of directions and questions such as ‘What did you observe in a stringed mechanism (Fig. 2)? Please explain your reason’, ‘What did you observe in a stringed mechanism (Fig. 3)? Please explain your reason’, ‘What did you observe in a stringed mechanism (Fig. 4)? Please explain your reason’. In this process, teacher monitors students and their interactions with each other, so that (s)he enables students to conduct an interpretive discussion. Further, (s)he can explain unclear points but refrains from any clue.

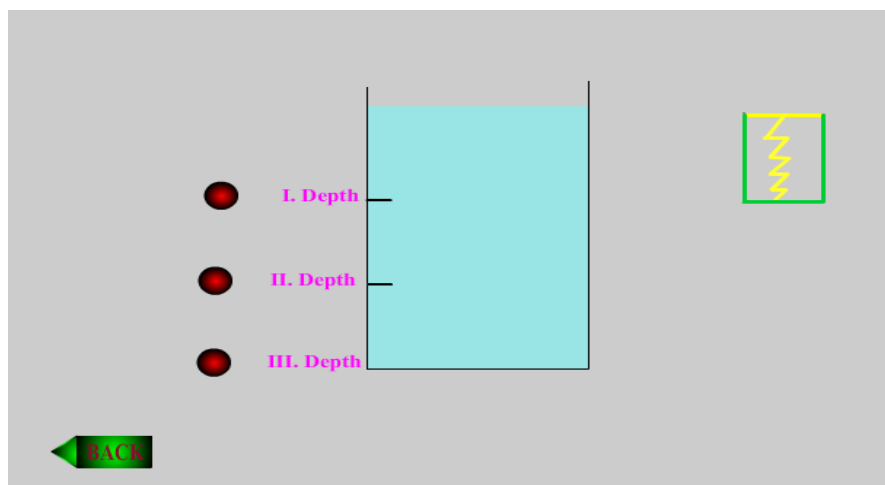


Fig. 2. Experiment screen.

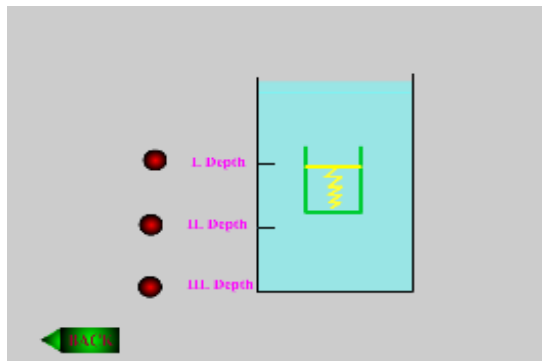


Fig. 3. Experiment screen.

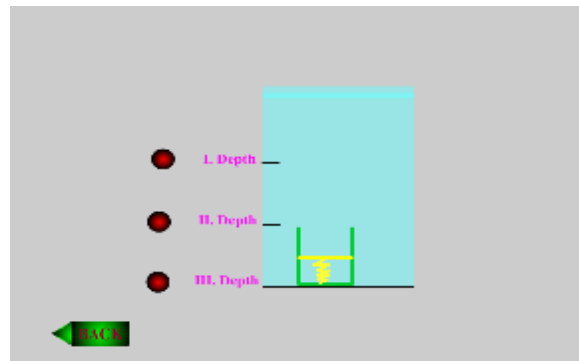


Fig. 4. Experiment screen.

Note: A stringed mechanism means that it indicates liquid pressure.

Explain: After each group completes the activities, a class discussion is conducted to get students to be aware of their peers' notions. The teacher introduces analogy called '*which of strawberries in Fig. 5 is the most squeezed?*'. Later, students are asked to match the analogy with how deepness affects liquid pressure. To distinguish analog from targeted conceptions, analogy map is used, thereby, students clarify where the analogy breaks down. Then, teacher confirms or disconfirms students' gained experiences by addressing 'liquid pressure' concept.

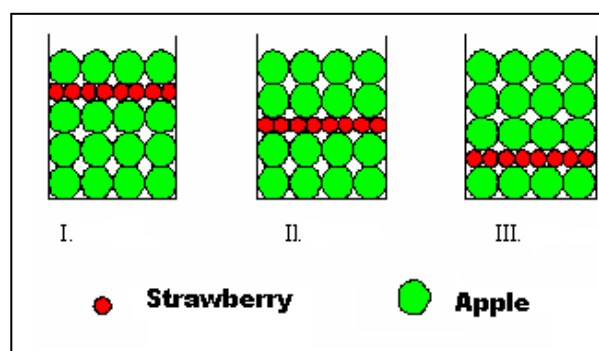
Fig. 5. Analogy called '*which of strawberries in Fig. 5 is the most squeezed?*'

Table 1. Analogy map

Analog Feature	Comparison	Target Feature
Apples	Compared to	Liquid molecules because it engenders liquid pressure
Strawberries	Compared to	Stringed mechanism in the liquid because it is submerged in different depths.
Strawberry's depth in the apples	Compared to	Liquid depth because it influences liquid pressure
Crushing strawberry	Compared to	Compressing stringed mechanism because liquid molecules squeeze it as a result of liquid pressure
Apple	Not compare to	Liquid molecule because we cannot see liquid molecules by the naked eyes. Also, size of each liquid molecule is the same, but size of each apple may change and differ from one another
Crushing strawberry	Not compare to	Compressing stringed mechanism because it can return to its initial position when liquid pressure is removed

Elaboration: Students are requested to carry out two simulations activities (Fig. 6) to extend their newly structured knowledge. By doing this, students can grasp

how liquid type (i.e. water, mercury and alcohol) influences liquid pressure. The questions *'if you dropped a stringed mechanism into three different beakers filled fully with water, mercury and alcohol (at the same volume), could you imply its position in each beaker?'*, *'what did you observe for a stringed mechanism into each beaker? Please defend your response'* are asked to have a better student engagement.

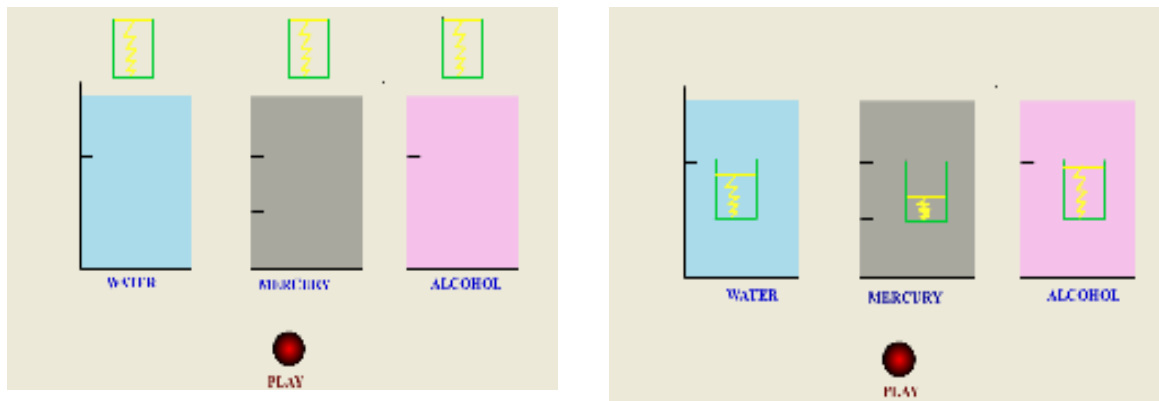


Fig. 6. Experiment screens

Evaluation: Using related questions, teacher not only monitors how their students' conceptual understandings progressed but also reinforces students' newly structured knowledge claims.

1. Salih is planning to devise a water rotor that can rotate rapidly as seen in the Fig. 7. Which of the followings should be done to achieve this goal? [Please select a choice in the first tier and explain your reason in the second tier]

- He should use a denser liquid than water.
- He should lift water container upwards.
- He should pour the same liquid to a wider volume container.

d. A bit salt should be added into the container filled with water.

Because

2. If you locate a water tank in your apartment, what do you think about where the best place is? Please defend your response

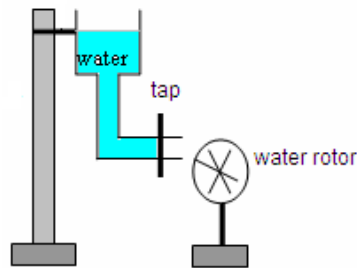


Fig. 7. Planning to devise a water rotor

4. Conclusion

To teach liquid pressure and the effect of liquid type, combining different conceptual change methods within a 5E model is illustrated here. However, the study has some limitations in providing concrete evidence how it works since the paper is a hypothetical paper. For this reason, to investigate its applicability in a comparative manner, further research should be undertaken. Since teachers may learn how to incorporate their students' pre-existing knowledge by taking the current study into account, they are able to design their own sample teaching to other topics [38-40].

Acknowledgement

This study was supported by Research Fund of Karadeniz Technical University, Project Number: 2007.116.004.2

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