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Addressing Primary 5 Pupils’ Alternative Conceptions On Condensation And Evaporation

Using Concept Videos In Inquiry Science

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Abstract

The use of concept videos in science was designed to incorporate the teaching and learning of 21st Century skills in particular self-directed learning (SDL) which focus on developing thinking, communication and management skills in pupils. Science concepts are often abstract for young children, especially those in primary schools, to grasp. Pupils often bring to the classroom their own sets of science ideas, believes or alternative science concepts which may not be accurate and may contain serious misconceptions. Teachers need to constantly unteach and correct their alternative concepts before effective learning can take place. However, these unscientific ideas, believes or alternative conceptions that pupils have are usually difficult to change through routine classroom instruction. Addressing pupils' alternative conceptions is critical and if this is not addressed at early stage, it will impede their understanding of science concepts at higher study level. This paper examines the impact of using concept videos in 5E inquiry-based science lessons (IBL) to trigger the thinking of primary five pupils (11-years old) as well as elicit any prior knowledge that pupils have into an active investigation of science concepts explicitly applied in authentic situations. A team of teachers created videos that present learners as subjects with alternative conceptions based on authentic situations in everyday life. These customised concept videos produced in-house are then used at crucial "hinge points" in a lesson to elicit their existing thoughts and trigger further in-depth thinking in pupils.

Keywords:

21st century skills; inquiry-based learning; self-directed learning; concept video
ADDRESSING PRIMARY 5 PUPILS' ALTERNATIVE CONCEPTIONS ON CONDENSATION AND EVAPORATION USING CONCEPT VIDEOS IN INQUIRY SCIENCE

Introduction

Science education is currently going through a process of change in many nations around the world so as to better prepare future citizens to understand science and technology issues in a rapidly evolving society (Millar & Osborne, 1998). Similarly, in Singapore, the current primary science education stresses the importance of pupils developing a deep understanding of core scientific knowledge and the methods of science so as to better prepare our pupils to function and contribute in an ever increasingly technologically-driven world (Science Syllabus Primary, 2008).

Science concepts are often abstract for young children, especially those in primary schools, to grasp. Pupils often bring to the classroom their own sets of science ideas, believes or alternative science concepts which may not be accurate and may contain serious misconceptions. Having alternative science conceptions are common among pupils. As teachers, we need to elicit these ideas from pupils so that we are able to address them during our lessons. If we were to ignore the ideas of these pupils, this could end up hindering their learning processes. There are many ways to draw out misconceptions from pupils and using concept video is one possible technique. It is also generally agreed that traditional instruction that does not take into account the existing beliefs of pupils is largely ineffective in changing their misconceptions.

Scientific inquiry may be defined as the activities and processes which scientists and pupils engage in to study the natural and physical world around them. In its simplest form, scientific inquiry may be seen as consisting of two critical aspects: the what (content) and the how (process) of understanding the world we live in. The learning must encourage pupils to think
and talk more like scientists. The teaching of science would need to be more than the content of science, it also had to be about science as a way of thinking and investigating. Teachers need to constantly unteach and correct their alternative concepts before effective learning can take place. However, these unscientific ideas, believes or alternative conceptions that pupils have are usually difficult to change through routine classroom instruction. Addressing pupils' alternative conceptions is critical and if this is not addressed at early stage, it will impede their understanding of science concepts at higher study level. High-stakes examinations such as PSLE Science assess pupils' science proficiency with respect to the aims of the Primary Science Education (CPDD, 2008). A key part of the assessment objective is the application of knowledge and process skills. The construction of explanations including identifying evidence, interpreting question, and evaluating claims (Driver, Newton, & Osborne, 2000) is a basic practice in science.

The use of concept videos in science was designed to incorporate the teaching and learning of 21st Century skills in particular self-directed learning (SDL) which focus on developing thinking, communication and management skills in pupils. The purpose of this study is to examine the impact of using concept videos in 5E inquiry-based science lessons (IBL) to trigger the thinking of primary five pupils (11-years old) as well as to elicit any prior knowledge that pupils have into an active investigation of science concepts explicitly applied in authentic situations.

**Theoretical Framework**

The discovery of the persistence of pupils' misconceptions (Osborne, 1983) has led to a surge of investigation in the field of science education. Pupils have their own conceptions of science and how it works which is often based on their observations of phenomena in daily life. A familiar observation is the misconceptions found in the Primary 5 topic on the changes of states of water which is often complex and difficult for pupils to comprehend.
Pupils may think... | Instead of thinking...
---|---
Condensation is when air turns into a liquid. | Condensation is water vapour in the air that cools enough to become a liquid.
Condensation on the outside of a container is water that seeped (or sweated) through the walls of the container. | Condensation of water vapour happens when the water vapor in air comes in contact with a cool surface.

Pupils' alternative conceptions are considered undesirable by teachers as these conceptions will hinder their learning. Thus it is important to identify the pupils' beliefs before starting to teach something new as teachers need to constantly unteach the misconceptions or alternative frameworks for effective learning to occur. As learning is dynamic and interactive (Piaget, 1975) the construction of science knowledge for pupils can be assisted through a sequence of activities in the lessons structured in a manner that will challenge the pupils' current conceptions and allow for reconstruction of concepts to occur through discussions with their peers.

Pupils' alternative conceptions could be effectively used as a springboard to the introduction and teaching of science topics. "Unless teachers identify children's views and design their teaching accordingly, some children's ideas will not change, as will change in unanticipated ways, as a result of formal science teaching." (Osborne & Cosgrove, 1983). Pupils' alternative conceptions can also serve as starting points for discussion and investigations. This also helps the pupils to be "cognitively active" for classroom investigations and to make their thinking on the science concept explicit (Pine et al., 2001).

Although a lot of studies on children's alternative conceptions and the strategies have been conducted over the years, no formal studies have been reported on Primary School pupils in Singapore. By conducting a study with our pupils, we hope to fill the gap in the research on
how a particular strategy - concept videos can be used to address alternative conceptions in the teaching and learning of science for primary school pupils.

Methodology

Research Questions

This research aims to elicit and examine Primary 5 pupils' conceptions (scientific or alternative) of two processes associated with water, namely, condensation and evaporation. In particular, there are three research questions:

The aims of the study are:

What conceptions do Primary 5 pupils have on condensation and evaporation?

To what extent do concept videos address the Primary 5 pupils' alternative conceptions in condensation and evaporation of water?

What alternative conceptions revealed in the Primary 5 pupils are still present after the intervention using concept videos?

Research Design

In order to analyse the impact of the use of the Concept Video lesson package on teaching and learning in the classroom, we decided to observe it in practice. We worked with a group of five science teachers from our Professional Learning Circle (PLC) team to film four pupils, each verbalising their ideas with regards to a common phenomena that they see in their daily lives (water droplets found on the surface of a cold glass of water). This Concept Video is based on common misconceptions of our pupils on "condensation of water vapour" which we have identified. Lesson plan on the flow and procedure for the activities, guiding questions and the Concept Video were provided in the lesson package to ensure that pupils would have the opportunities to question and explain their thinking as they connect to real-life experiences.
Quantitative data through pre and post-tests were collected from the experimental and comparison groups. The main questions focused on the idea that water droplets found on the surface of cold water is a result of condensation of warm water vapour in the surrounding air on a cooler surface. Class discussions before and after the concept videos allowed for oral exchange, probing and clarification of initial ideas as the pupils shared their views based on their observations. Changes in pupils' conceptions were also obtained through individual reflections at the end of the lesson.

Events and Key Questions (Osborne & Cosgrove, 1983)

| Cubes of ice placed in a metal container with the lid on. After some time, moisture from the air condense on the cold surface of the container. | Questions:
From where did the water on the outside of the container come from?
What do you mean by the term "condensation"? |

The Sample

This is a neighbourhood school from the southern part of Singapore. The pupils are mostly from the middle socio-economic group. The science teachers who conducted the lessons were also members of the PLC group. The convenient sampling method was used since the purpose of the study was to gain insights into the science understandings of pupils in the primary school and their subsequent conceptions after the intervention.

Profile of the Sample

Six Primary 5 classes (A-F) were divided into experimental and comparison groups based on the quasi-experimental design and random sampling was not possible in this situation as the pupils in the classes have been streamed according to their academic abilities for English, Mathematics and Science. Primary 5A consists of pupils who were strongest academically while pupils in Primary 5F were the weakest. There was a combination of boys and girls in
the study. Classes A, D and E used the Concept Video package where the pupils considered and discussed their ideas and conceptions of condensation and evaporation during the lesson whilst the control groups followed strictly to the lesson plan as proposed by teaching package provided by the course books publisher.

Data Collection
Pre and post tests were administered to all pupils in the experimental and comparison groups. Pre-tests were done one day before the lessons were conducted and post-tests were done one day after the lessons were completed. The pupils' responses and discussions were audio-taped and pupils' responses on the customized worksheets and discussion in relation to the concept videos were analysed. The teacher observers took some field notes during lesson observations of the experimental groups. Data was also obtained from the pupils' and teachers' reflections of the lesson.

Data Analysis
"Exit cards" and class discussion were used at the beginning of the lesson to elicit conceptions that Primary 5 pupils have on condensation and evaporation. From the lesson observations as well as the pupils' responses in the pre and post-tests, comparisons were made between the pupils' initial and subsequent ideas of "condensation on a cold surface" of the experimental and comparison groups. From the data, key words, phrases and the pupils' way of thinking and events that were repeated were sieved out (Bogan & Biklen, 2003). Significant sections of the video containing pupils' responses were highlighted for analysis and interpretation, as these will provide evidence to other alternative conceptions pupils may still have after the intervention using concept videos.

Findings
The objective of this study was to determine if there is an improvement in pupils' post test score after the intervention was introduced. Hence a paired T-Test was conducted in order
to see if there is a statistical significant difference between the pre and post test results.

Table 1. presents a summary of the results. Based on the table, it was observed that there was an improvement in their post-test result as compared to their pre-test result when the means of the pre and post-test were compared. The paired T-Test was done to confirm the statistical significance of the means. The T-values shown in the table indicated that there was a high statistical significance in the difference of the means for 5D pre-test (M=6.05, SD=2.74) and post-test (M=10.51, SD=2.76) conditions; t(37)=-8.11, p=0.00 and 5E pre-test (M=6.16, SD=2.71) and post-test (M=10.16, SD=2.27) conditions; t(30)=-8.14, p=0.00. These results suggested that the use of concept videos have impacted students' performance in answering exam-style questions relating to condensation and evaporation. Specifically, our results suggested that when concept video was used in the science lessons, their performance improved.

Table 1. Descriptive statistics for the pre and post test

<table>
<thead>
<tr>
<th>Group (Experimental)</th>
<th>Pre-test</th>
<th>Post-test</th>
<th>T-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>5B</td>
<td>39</td>
<td>9.88</td>
<td>1.83</td>
</tr>
<tr>
<td>5D</td>
<td>29</td>
<td>6.05</td>
<td>2.74</td>
</tr>
<tr>
<td>5E</td>
<td>31</td>
<td>6.16</td>
<td>2.72</td>
</tr>
</tbody>
</table>

Table 2. shows the comparison made in terms of independent t-Test for all the experimental groups post test. There was a significant difference in the scores for all the experimental groups and these results suggest that the use of concept video are able to address pupils alternative conceptions in condensation and evaporation of water.

<table>
<thead>
<tr>
<th>Group (Experimental)</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>F</th>
<th>Sig</th>
<th>t</th>
<th>df</th>
</tr>
</thead>
<tbody>
<tr>
<td>5B</td>
<td>39</td>
<td>11.09</td>
<td>2.30</td>
<td>0.224</td>
<td>0.637</td>
<td>0.932</td>
<td>66.0</td>
</tr>
<tr>
<td>5D</td>
<td>29</td>
<td>10.52</td>
<td>2.76</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Discussion

The change in the PSLE science questions since 2004 gives greater emphasis to critical thinking skills and the ability to apply concepts (SingTeach Issue 16 Jan-Feb 2009). The use of concept video further enhanced the learning of science where students were able minimize alternative conceptions on condensation and evaporation that they may have. When these alternative conceptions are minimized and the correct content knowledge had been acquired, pupils were able to apply the correct techniques in answering the questions.

Being equipped with the correct concepts encouraged greater student understanding. Through our classroom’s observation, it was observed that pupils have an increased level of confidence in answering exam-style questions using the correct scientific terms after the application of the intervention. With the improvement of pupils’ ability to answer the exam-style questions with less difficulty, the teachers also gained a sense of achievement and satisfaction. Assessment is an integral and vital part of teaching and learning (Boo Hong Kwen, 2007). Improvement in pupils’ performances serves to reaffirm the effectiveness of the school’s instructional programme.

Conclusion

Children have their own understanding of the world before receiving formal science education. In many cases, pupils’ alternative conceptions are not addressed in the curriculum and thus these alternative conceptions exist unchallenged. Based on our pre-test results and survey conducted in class, a significant number of Primary 5 pupils thought that water droplets found on the outer surface of a cold container is the result of frosting and coldness passing through the container. This further reinforces the fact that it is important to
come up with teaching approaches that challenge existing pupils’ ideas on the condensation and evaporation process of hot and cold water and organize activities that support conceptual change.

The positive impact of the concept videos on pupils cannot be denied as the lessons were more focused when pupils’ alternative conceptions were identified at the start of the lessons. Pupils were given opportunities to discuss and explore their conceptions through planning and conducting an investigation to test their hypotheses and then explain the scientific concept based on their observations. This strategy is useful as it allows pupils opportunities to find out ways to answer their questions and subsequently develop ways of understanding the world around them, as it is evident in the improvements made in the post-tests for the experimental group. Pupils in the experimental group have also expressed greater interest in science and are also able to understand the science concepts better after the Concept Video lessons. Teachers noted a change in the pupils’ responses for those who were identified with alternative conceptions at the start of the lessons. This is especially so for teachers who provided linkages between new and prior knowledge, giving more examples and non-examples of the condensation concept throughout the lesson.

**Limitations and Recommendation**

In a true experimental design, random sampling is preferred over experimental-group comparison design as it reduces the threat of subject characteristics where pupils in the better classes would reflect greater improvement in the post-test because of their language abilities and prior knowledge on the subject to be learnt. However due to the constraints posed by our current method of banding pupils based on their academic (English, Math and Science) results, it would not be possible to obtain a random sample in this case. To minimize the effect on results obtained being influenced by the research design, we have conducted our study over a wider sample size using six Primary 5 classes and also comparing data between 2 classes (A and B, C and D) which are similar in terms of language abilities and possible prior knowledge.

**References**

Goh, Ngoh Khang & Chia, Lian Sai. Teaching and Learning, 6(2), 66-72. *A practical way to diagnose pupils' misconceptions in science*. Institute of Education (Singapore).


Lucille Lee Kam Wah, Teaching and Learning, 16(1), 72-80. *Children's ideas in science: some strategies for teacher intervention*. Institute of Education (Singapore).


