Learning Mathematics in Group Work  
(A Repeated-Measures Experimental Design)

Endah Retnowati

**Research Topic: Group Work**
Humans, as social creatures, frequently form groups to solve problems together. School students are often allocated to groups to study in areas such as mathematics. It is assumed that studying in groups may be advantageous in terms of developing collaborative skills. But, how should we design effective instruction for learning mathematics during group work?

**Cognitive Load Theory**
CLT is an instructional design theory based on human cognitive architecture. Human cognitive architecture is a natural information processing system that can be summarised by five principles as follows.

**Five Principles**
1. The information store principle (LTM)
2. The borrowing and reorganising principle (Explicit Instruction)
3. The randomness as genesis principle (PS)
4. The narrow limits of change principle (WM)
5. The environmental organising and linking principle (LTWM)

**Human cognitive architecture**

<table>
<thead>
<tr>
<th>Sensory Memory</th>
<th>Working Memory</th>
<th>Long-term Memory</th>
</tr>
</thead>
<tbody>
<tr>
<td>The input/reject</td>
<td></td>
<td>The initial store</td>
</tr>
</tbody>
</table>

**Worked Example**
Instruction is designed to facilitate schema acquisition and automation. Based on cognitive load theory, the use of worked example has proved to be a powerful instructional procedure for novice learners in various domains by countless controlled experiments. Specifically, to facilitate learning, instruction should be designed to minimise extraneous cognitive load as far as possible. At the same time, instructors need to determine the level of intrinsic cognitive load, which is the amount of information to be presented based on the element interactivity of the learning material.

**Hypothesis**
1. Students will benefit from learning using worked examples.
2. Students will benefit from learning collaboratively using more-complex worked examples.
3. Students will benefit from learning less-complex worked examples individually.

**Experimental Design**

<table>
<thead>
<tr>
<th>Element Interactivity</th>
<th>Stage 1</th>
<th>Stage 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning approach/Setting</td>
<td>WE/Idv</td>
<td>PS/Idv</td>
</tr>
<tr>
<td></td>
<td>WE/GW</td>
<td>PS/GW</td>
</tr>
<tr>
<td>WE : Worked Example Approach</td>
<td>PS : Problem Solving Approach</td>
<td></td>
</tr>
<tr>
<td>GW : Group Work Setting</td>
<td></td>
<td></td>
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</tbody>
</table>

**Measurements**
Performances on similar test after each stage and transfer test at the end. Cognitive Load on all learning and test stages using a 9-scale rating.

**Participants & Learning Material**
Grade 7, Mathematics regular classroom
Geometry: Relation of angles formed by parallel lines and a transversal line, seven theorems to learn:
1. A revolution angle 5. Corresponding angles
2. Complementary angles 6. Alternate angles
3. Supplementary angles 7. Co-interior angles
4. Vertically opposite angles

**Example of the material**

1. Postline: Find the value of $x$ and give reasons for each step.
   \[ \ldots \]
   Solution: $x = \ldots$ (addition angles between parallel lines is 180°)

2. Postline: Find the value of $x$ and give reasons for each step.
   \[ \ldots \]
   Solution: $x = \ldots$ (two lines parallel to each other are 180°)

3. Postline: Find the value of $x$ and give reasons for each step.
   \[ \ldots \]
   Solution: $x = \ldots$ (two lines parallel to each other are 180°)

4. Postline: Find the value of $x$ and give reasons for each step.
   \[ \ldots \]
   Solution: $x = \ldots$ (two lines parallel to each other are 180°)
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Abstract for Poster Presentation

This paper provides a detail description of the research methodology utilised to investigate a learning strategy based on a cognitive load theory. The current research project is proposed to investigate how students learn mathematics in a group work setting using instruction strategies based, Cognitive load theory (Sweller, 2010; Sweller, van Merrienboer, & Paas, 1998) is developed using our understanding on human cognitive architecture. In particular, this investigation attempts to further examine performances and cognitive load after learning a worked example instruction in two types of complex material during individual and group learning experiences. A worked example approach has been shown to be very effective by many studies in various domains (Atkinson, Sharon, Renkl, & Wortham, 2000) as well as its uses for group learning (Kirschner, Paas, & Kirschner, 2009, 2010; Retnowati, Ayres, & Sweller, 2010). In this experiment, worked examples for learning geometrical theorems are designed to minimise extraneous cognitive load. The group work is set up using a group role approach to stimulate individual accountability and minimise the coordination cost. A 2 (learning approach: Worked Example vs. Problem Solving) x 2 (learning setting: Individual vs. Group Work) x 2 (types of complexity: less vs. more) design will be used, where the types of complexity is the repeated measures factor. It is hypothesised that (1) students will benefit from learning using worked examples (2) students will benefit from learning collaboratively using more-complex worked examples; (3) students will benefit from learning less-complex worked examples individually.

References


Dear Endah

A poster would be very appropriate for you to present your research design and get feedback from the research community.

We will be in touch in the near future with further detail about the conference.

Regards
Kirsty

From: Endah Retnowati [z3177200@zmail.unsw.edu.au]
Sent: 15 September 2010 14:44
To: Kirsty Young
Subject: Abstract for Poster Presentation IER

Dear Dr Kirsty Young

I would like to present my early stage of research in the IER conference this year using a poster. The research has not had a data yet, but I am willing to get input in the hypothesis and experimental procedure. I am looking forward to hearing from you. Thanks.

Regards
Endah

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kirsty.young@uts.edu.au

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**Your Details**

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