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?

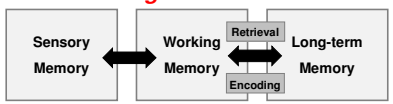
Cognitive Load Theory

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



The modal model

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.*

Split Attention Effect

If a worked example includes two or more relevant sources of information that need to be processed simultaneously to understand the material, these sources of information should be physically integrated

Redundancy Effect

Worked examples should not include redundant information because unnecessary additional information may interfere with meaning construction.

Expertise Reversal Effect

Worked examples may be redundant for higher level learners. Therefore, instruction should be altered to accord with a learner ' s knowledge base.

Variability Effect

Worked examples that are highly varied in structural features may allow students to learn various categories of problems and which solutions are required to solve particular categories. Variation of worked examples may result in high element interactivity, however, more importantly, this allows students to learn how to recognise which solution is applicable to which problem category and thus increase their knowledge.

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

	Stage 1		Stage 2	
Element Interactivity	Low		High	
Learning approach/ Setting	WE/Idv	PS/Idv	WE/Idv	PS/Idv
	WE/GW	PS/GW	WE/GW	PS/GW

WE : Worked Example Approach ***Idv : Individual Setting***
PS : Problem Solving Approach ***GW : Group Work Setting***

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

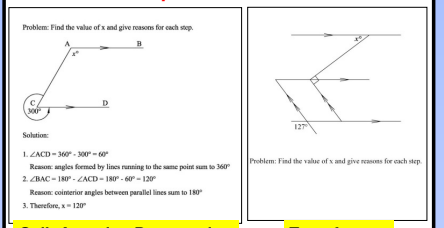
Participants & Learning Material

Grade 7, Mathematics regular classroom

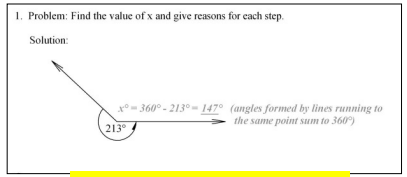
Geometry: *Relation of angles formed by parallel lines and a transversal line, seven theorems to learn:*

1. A revolution angle
2. Complementary angles
3. Supplementary angles
4. Vertically opposite angles
5. Corresponding angles
6. Alternate angles
7. Cointerior angles

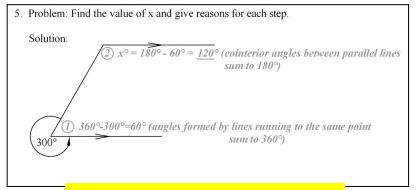
Example of the material



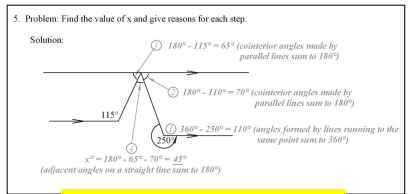
Split Attention Presentation **Transfer test**



One step solution worked example



Two step solution worked example



Four step solution worked example

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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 cocnitive 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

Atkinson, R. K., Sharon, J. D., Renkl, A., & Wortham, D. (2000). Learning from Examples: Instructional Principles from the Worked Examples Research. *Review of Educational Research, 70*(2), 181-214.

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Sweller, J. (2010). Element Interactivity and Intrinsic, Extraneous, and Germane Cognitive Load. *Educational Psychology Review, 22*(2), 123-138.

Sweller, J., van Merrienboer, J., & Paas, F. (1998). Cognitive Architecture and Instructional Design. *Educational Psychology Review, 10*(3), 251-296.

RE: Abstract for Poster Presentation IER

Kirsty Young [Kirsty.Young@uts.edu.au]
Sent: 15 September 2010 16:09
To: Endah Retnowati

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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Note: Intending presenters must pay registration fee at the time of emailing their Abstract. See over for Conference Registration Rates.

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Postgraduate students from all fields of educational research are invited to submit an abstract in one of the following formats:

Poster Presentation (preferred format)
200 word Abstract
The poster format is a common and accepted conference presentation format. It is ideally suited to visual presentation of ideas and allows for interaction between the researcher and people interested in his or her work. Posters will have a dedicated presentation timeslot of one hour.

Poster Dimensions
Approximately 4 A3 size sheets of paper

This format will suit students who wish to present their ideas and gain experience in a formal conference setting. This format may also suit students who have formulated a clear research plan or who have preliminary research data to report.

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Presenters have a 20 minute timeslot in which to conduct a formal conference presentation, allowing for 5 minutes question time.

- Eligible for a Regional Student Travel Grant
- Eligible for publication in *Issues in Educational Research*, a peer reviewed Australian journal.

Proposal Instructions

Please email your 200 word abstract to:

Dr Kirsty Young
kirsty.young@uts.edu.au

Your abstract and registration must be received by **15 September.** Your abstract will be included in a printed program.

Your abstract should include:

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- Contact details (email preferred)
- Name of your research supervisor
- Title of research
- An abstract of no more than 200 words

NOTE: state clearly if applying to present poster or paper

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For catering purposes please register to attend and/or present a paper. Complete this form and email or send to:

Dr Kirsty Young (kirsty.young@uts.edu.au)
University of Technology, Sydney
PO Box 222 Lindfield NSW 2070

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- Presentations
- Conference Buffet Dinner

Your Details

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Institution: School of Education, UNSW

(Eligible for a Regional Student Travel Grant ☐ please indicate)

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