Patterns of System Thinking While Using OPM Conceptual Models

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How to make popcorn in a pot:

1. Heat 2-3 tablespoons of oil in a pot. Place a uniform layer of corn seeds in the pot, and recommend stirring (on the top of the cups of corn grain, usually a teaspoon of salt, you can add salt to taste).
2. Grease the pot and increase the oil. Time to time shake side to side (course).
3. After 1-2 minutes, the nuclei are supposed to start exploding. At this point, do not open the lid until the process does not finish. It is recommended to shake the pot even during the explosions.
4. Once the explosions are no longer heard, lift the lid carefully and transfer to a large bowl (if left in a popcorn pot, it may burn, especially at the bottom).

**Oil**: 3 tbsp

**Corn Grain**: 1 cup

**Salt**: ½ teas

**Duration**: 4 min

**Stove Top**: Heat Level
- Moderate
- High

**Popcorn Making**: Popcorn

**Heating**

**Hot Oil**

**Mixing**

**Greased & Salted Grain Set**

**Frying & Shaking**

**Popcorn**
Introduction

Practice:
Asking Questions and Defining Problems

Developing and using models
Planning and Carrying Out Investigations
Analyzing and Interpreting Data
Using Mathematics and Computational Thinking
Constructing Explanations and Designing Solutions
Engaging in Argument from Evidence
Obtaining, Evaluating, and Communicating Information
Model-Based System Engineering

Text-based Models
Conceptual Models

Mental models

Conceptual models
OPM – Object Process Methodology

things

Object

Process

relation

Structural link

Behavioral link

- OPM edX courses
- OPM-OPCloud site
- OPCloud sandbox
System thinking

Understanding the Complex
Research Goal

To identify system thinking patterns while using OPM conceptual model

1. What patterns of system thinking can be recognized in the process of understanding system conceptual model?

2. Do certain patterns have greater presence in terms of frequency and time spent?

3. Do certain patterns of system thinking lead to better outcomes in understanding a conceptual model?
Sample

10 x 2 x 8 = 160

Participants x System models x Diagrams in each model = Cases
Research tool

- Verbal Protocol
- Verbal Protocol Analysis (VBA)

mental model
think-aloud
Research tool

- **Eye Tribe** eye tracker

- camera & infrared LED
- sampling rate: 60Hz
- Latency: < 20ms at 60Hz mode
- Accuracy: 0.5°-1°
- Calibration: 9 points mode
- screen resolution: 1280 *1024
- screen size: 15*12 inches
Research tool

• Questionnaire  6 open questions

Can you explain briefly how do you read and understand a diagram?
Research setup

Here is a system model. what can you say about the system? Please think aloud so that we can learn how people perceive and understand models.
## Preliminary Findings

### Six Patterns’ Types

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>o</td>
<td>and there is a soap.</td>
</tr>
<tr>
<td>o-s-o</td>
<td>the dishwasher has trays</td>
</tr>
<tr>
<td>o-t-p</td>
<td>the soap is consumed by the cleaning process</td>
</tr>
<tr>
<td>p</td>
<td>so here we can see the dishes’ washing &amp; drying process</td>
</tr>
<tr>
<td>p-s-p</td>
<td>cleaning consists of dishes loading, soap loading, and program choosing</td>
</tr>
<tr>
<td>p-t-o</td>
<td>heating changes the water temperature in case they are cold</td>
</tr>
</tbody>
</table>
Preliminary Findings

Patterns’ frequency

Object-base patterns
N= 343

- o: 48
- o-s-o: 69
- o-t-p: 226

Process-base patterns
N= 662

- p: 211
- p-s-p: 96
- p-t-o: 355
Preliminary Findings

frequency of Object vs Process Patterns by participant

$X^2(9)=15.18$, $p>.05$
Preliminary Findings

Eye scanning – heat map
Preliminary Findings

Eye scanning – time spent on each thing
Open question

Can you explain briefly how do you read and understand a diagram?

“...the **processes at first**, and then at the links connecting them to objects...”

“I start with the **processes** and try to understand their sequence and their operands. Then I look for enablers.”

“...**subprocesses and then** the objects linked to each subprocess.”
Discussion

Object oriented vs Process oriented

Possible explanation for the process priority:

- Process’ name usually includes object’s name ("Dish Cleaning")
  no need to look for the main object related to the process.

- Differences in things’ colors – blue vs green
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Thank you!

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