Article title

Introduction of a Model-Based Approach to Psychology Class: Class Practice for Serial Position Effect Experiments

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Presenter's Resume

Kazuhisa Miwa is currently a professor of the graduate school of informatics at Nagoya University.

He received the Ph. D degree in information science from Nagoya University in 1989. He joined the psychology department of Carnegie Mellon University as a visiting professor from 1991 to 1992.

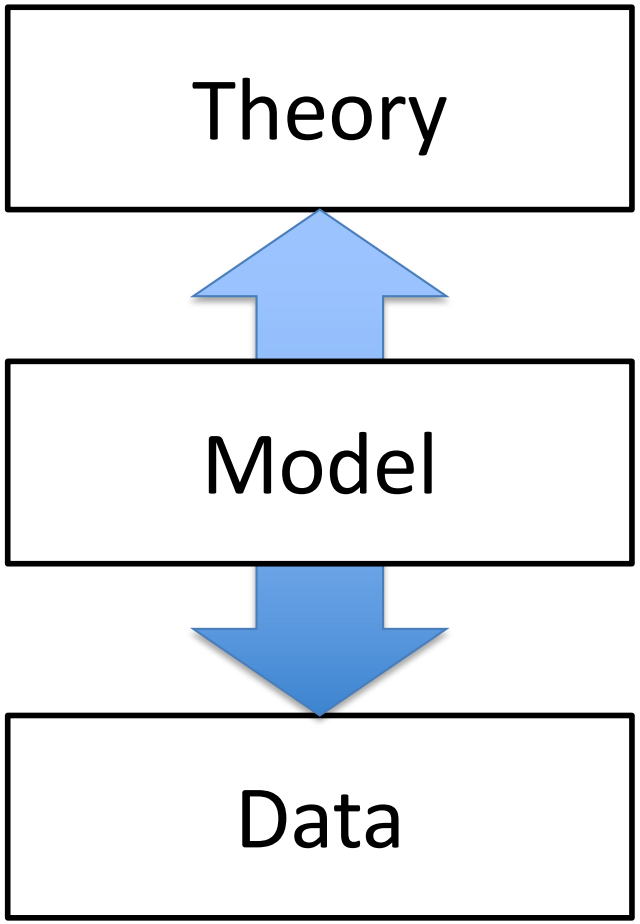
He has worked in the field of cognitive science throughout these 20 years. His research interest is in human higher order cognition such as creativity and scientific discovery. He has explored these themes by combining psychological-experimental approach and computational-model-based approach. He also has developed intelligent tutoring systems and science education programs based on the theory of human cognition.

Scientific Discovery Learning

- Experiencing scientific activities in class rooms
- Computer simulations in science education
- Evidence of Effectiveness (de Jong, & van Joolingen, 1998; Rutten, van Joolingen, van der Veen, 2012)
  - Conceptual understanding
  - Less time
  - Prediction of experimental results

Computational Model as Mediator

(Anderson, 1993)



A computational model predicts data pattern quantitatively.

A theory corresponds to data directly thorough a model.

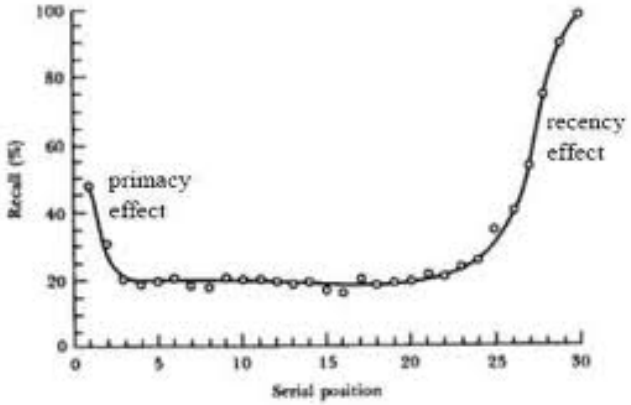
Computer simulation methods

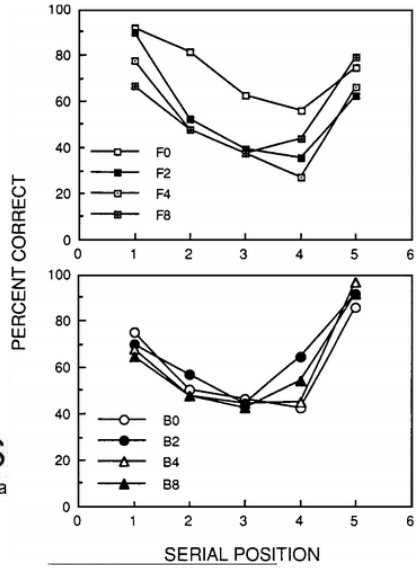
- Natural Sciences and Engineering
  - Physics, Biology, Chemistry, Engineering, Earth science, Computer science, General sciences, etc.
  - 110 million simulation programs
    - https://phet.cololado.edu

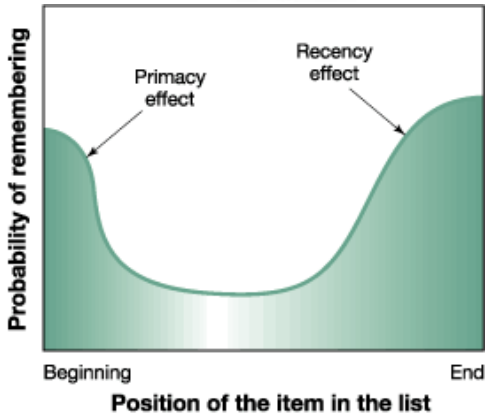
- Cognitive Science
  - Psychology

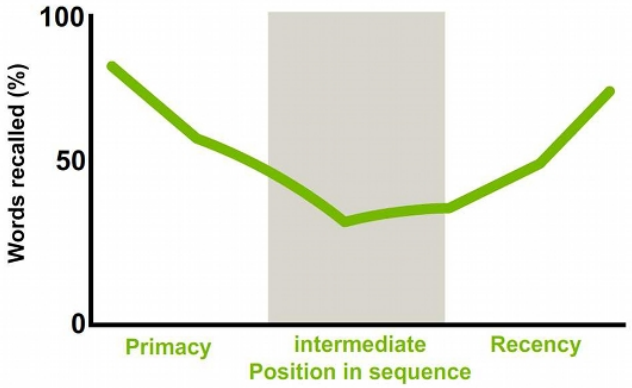
Serial Position Effect

People tend to begin recall with the end of the list (the **recency effect)** and with the first few items (the **primacy effect**) more frequently than the middle items.









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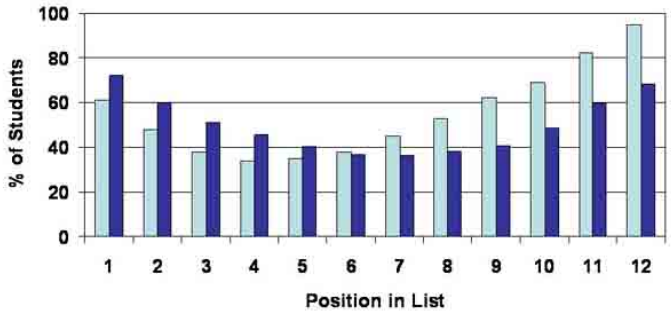
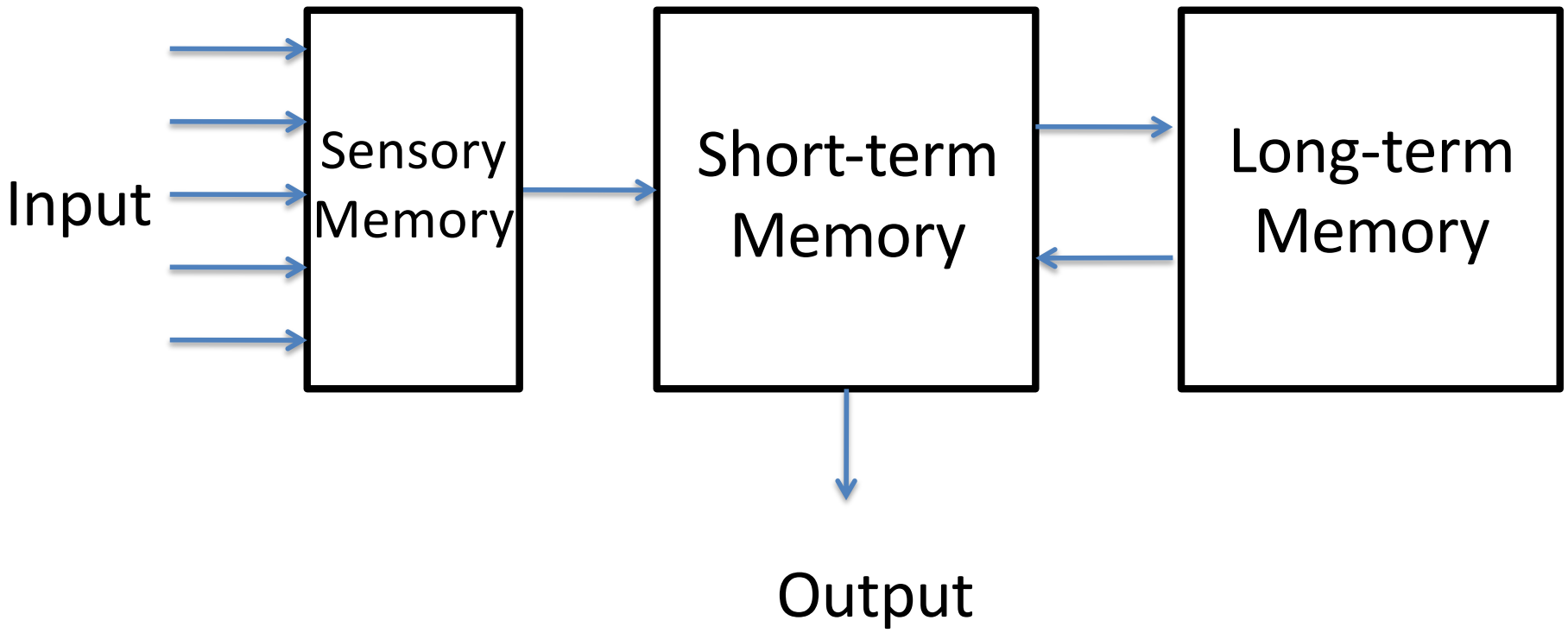
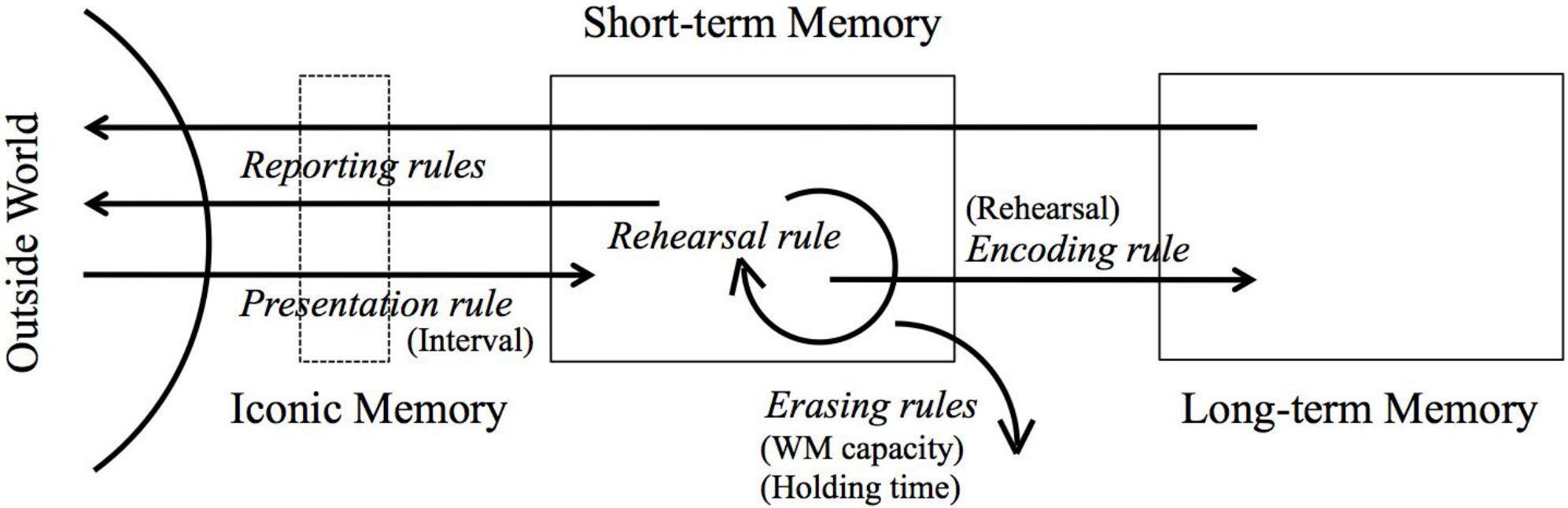


Dual Storage Theory

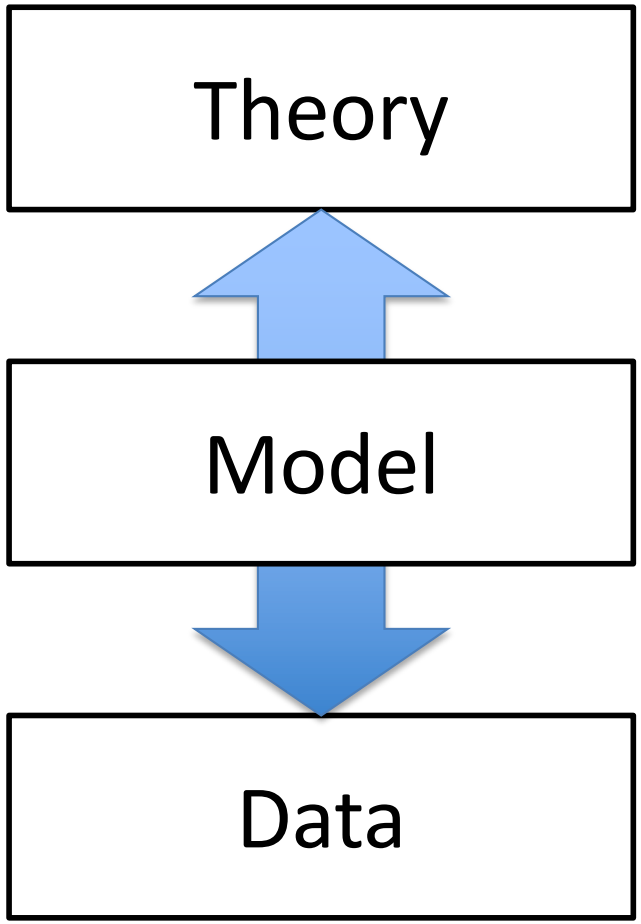
(Atkinson & Shiffrin, 1971)



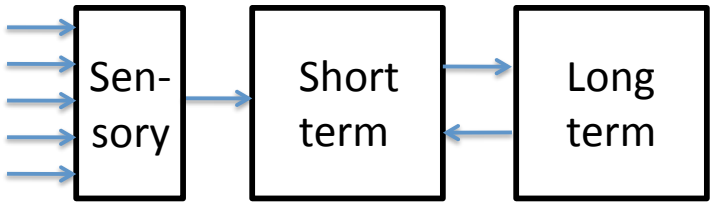
Dual Storage Model



Computational Model as Mediator



Theory

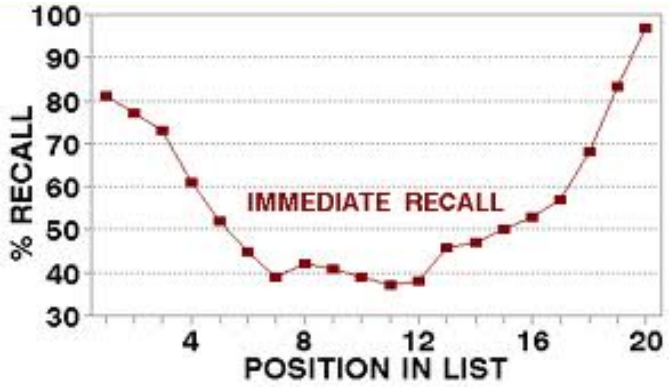


Model

Computational Model

- Visualization of interaction between Short- and Long-term memories
- Simulations in various situations while controlling memory capabilities

Data
(Experimental Results)



Dual Storage Model

TABLE I. RULES OF THE MODEL

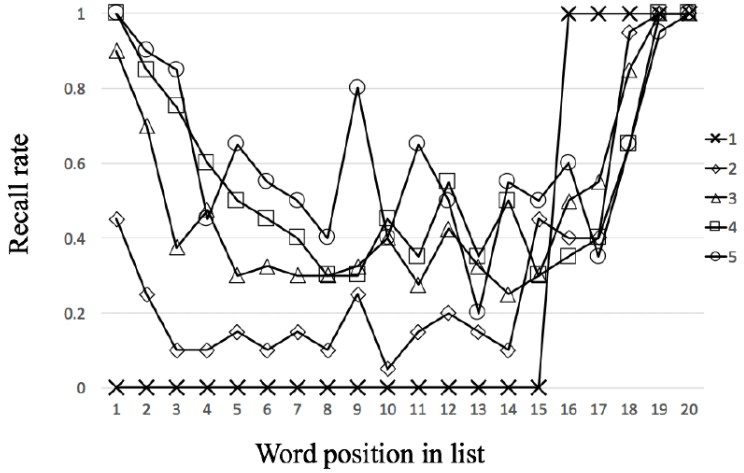
Rule	Function
Presentation rule	presents an item and encodes it into the short-term memory
Two erasing rules	erase items from the short-term memory after the time limit for holding items has passed, and erase items from the short-term memory when the number of items has exceeded the working memory capacity
Rehearsal rule	performs rehearsals of items in the short-term memory
Encoding rule	encodes items into long-term memory when the number of rehearsals exceeds a threshold value
Two reporting rules	report items from the short-term and long-term memories when asked to report memorized items after all items have been presented
Two rules	for stopping the system and increasing the time counter

Dual Storage Model

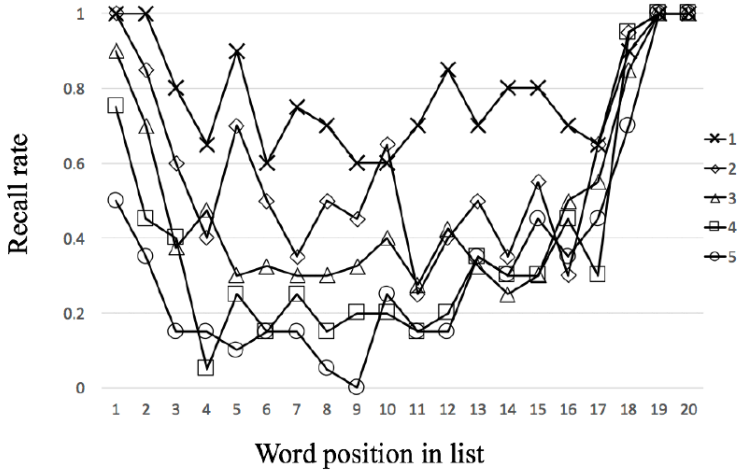
TABLE II. PARAMETERS OF THE MODEL

Parameter	Function
Presentation interval	controls an interval between two successive item presentations
Rehearsals for encoding	specifies the number of rehearsals needed for encoding items into the long-term memory
Working memory capacity	specifies the number of items that can be simultaneously stored in the short-term memory; when the number of items exceeds this limit, the oldest item that was stored earliest is erased from the short-term memory
Holding time	specifies a time limit for holding items in the short-term memory; when no rehearsals are performed beyond the time limit, the item is erased from the short-term memory

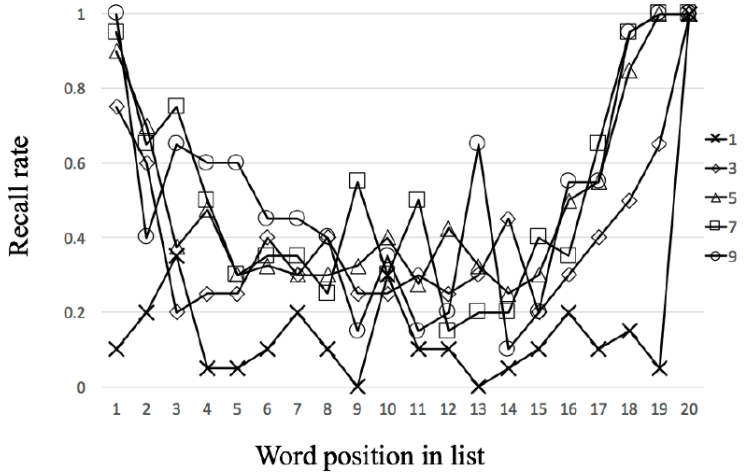
Results of Simulations



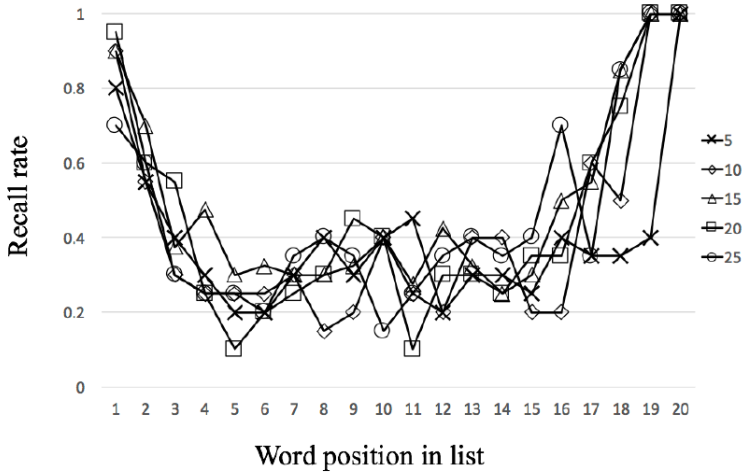
(a) presentation interval



(b) rehearsals for encoding



(c) working memory capacity



(b) holding time

Results of Class Practice

Assignment 1

TABLE III. DISTRIBUTION OF REPORT SCORES IN ASSIGNNMET 1

Score	0	1	2
Number (rate)	10 (0.09)	35 (0.30)	70 (0.61)

Assignment 2

TABLE IV. DISTRIBUTION OF REPORT SCORES IN ASSIGNNMET 2

Score	0	1	2
Number (rate)	6 (0.05)	43 (0.38)	63 (0.56)

Discussion and Conclusions

- Mental model construction (Johnson-Laird, P. N., 1983; Gentner, D. & Stevens, A.L., 1983)
  - Participants performed mental simulations of the memory process for predicting the pattern of the experimental results.
  - Participants internalized the computational model to their mind for mental simulations by learning the memory process with the cognitive simulator.

Discussion and Conclusions

- SBF model (Goel, A. K., Rugaber, S. & Vattam, S, 2009)
  - Structure, Behavior, and Function.
  - Experts referred to Behaviors and Functions more. (Hmelo-Silver, C. E. & Pfeffer, M. G., 2004).
- The cognitive simulator visualized Behaviors of the memory system and let participants notice Functions of each module.