

# An Adaptive Web-based Component for Cognitive Ability Estimation

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# Two different areas of research

- Adapting ITS behavior to learner traits
  - to improve accuracy of student models
  - to make better pedagogical decisions
  - Example:
    - Cognitive development computer-based test [Arroyo,00]
- Adaptive testing
  - to make testing fast and accurate
  - Example:
    - SIETTE web-based adaptive testing system [Rios,99]

# Cognitive development test

**Formal thinking**



Untitled

You pour the water in the glasses into the containers that are next to them. Where do you think the water is going to be in those containers, after you pour the water? Click in the place where you think the water is going to be in both containers.

*I am ready...*

Untitled

Is it better to give this plant a can of water every day or every week? Experiment with these plants.

1 a day

1 a week

90° F

50° F

1 a day

1 a week

90° F

50° F

1 a day

1 a week

90° F

50° F

*Go on*

**Concrete thinking**

# Validity and reliability

- Good at predicting math performance and time.
- Students succeed at concrete tasks more
- Built with an expert in Piaget psychology
- Reliable (take and re-take of test)
- Cognitive development x hint symbolism determines performance in an ITS

# SIETTE: An adaptive testing system

- Web-based
- Adaptive
  - Computerized Adaptive Testing
  - Item Response Theory

SIETTE

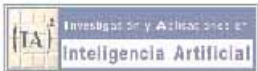
Sistema Inteligente de Evaluación mediante Test

para la TeleEducación.

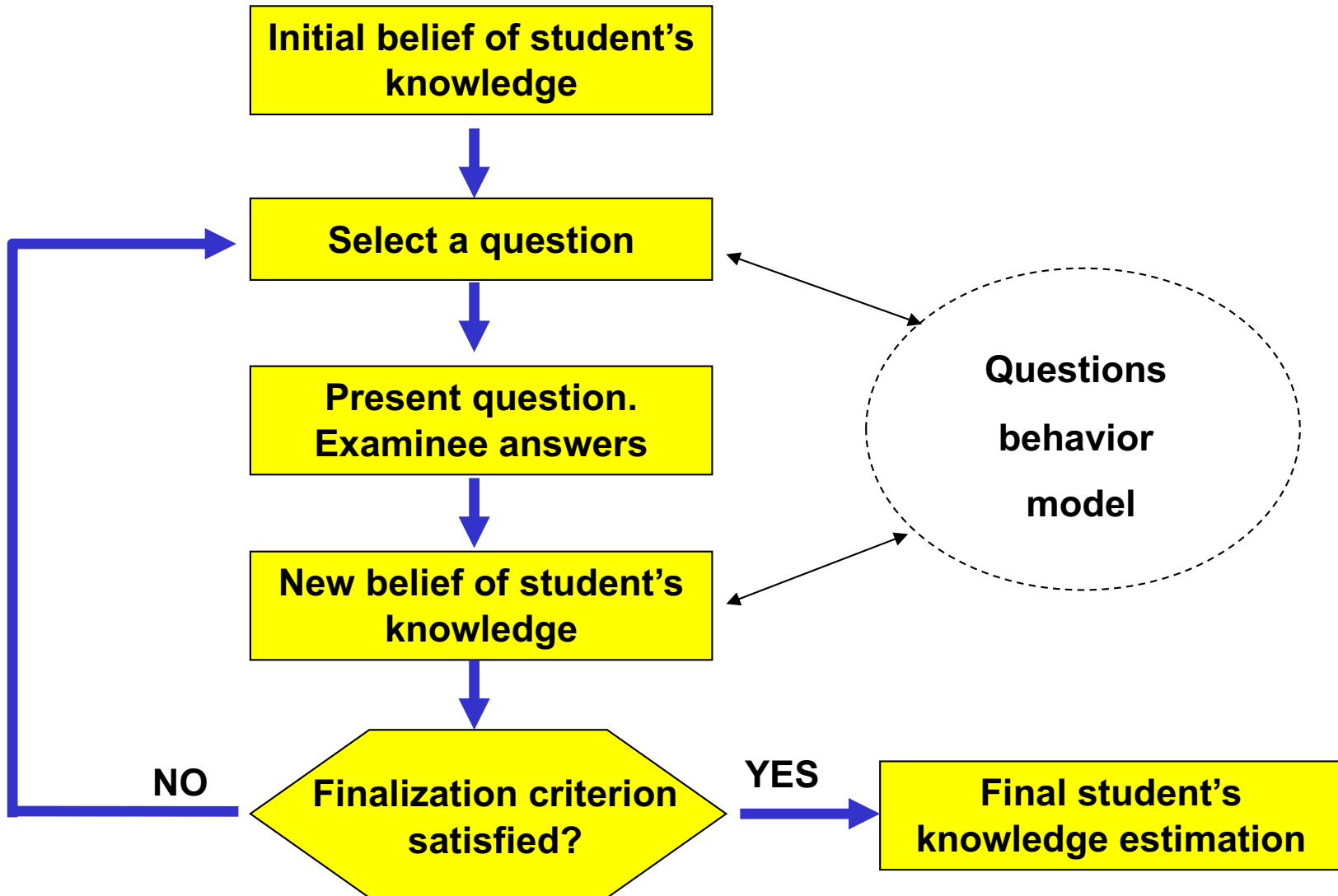


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# Computer Adaptive Testing



# Questions behavior model

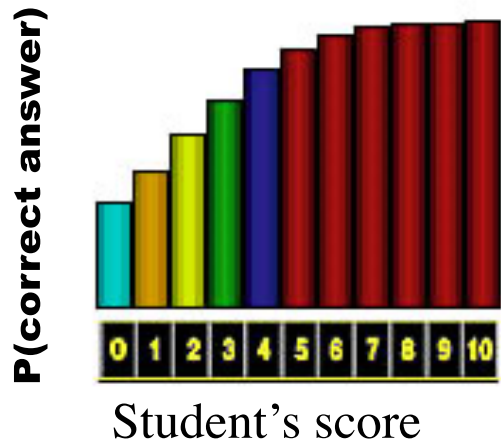
## 10 question test

(1010100000) Score = 3  
(1101001010) Score = 5  
(1110101000) Score = 5  
(1101101010) Score = 6

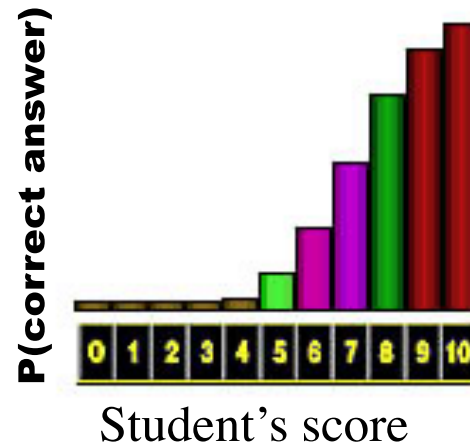
*Prior full-test-taker responses*

...

ICC for an easy question



ICC for a hard question



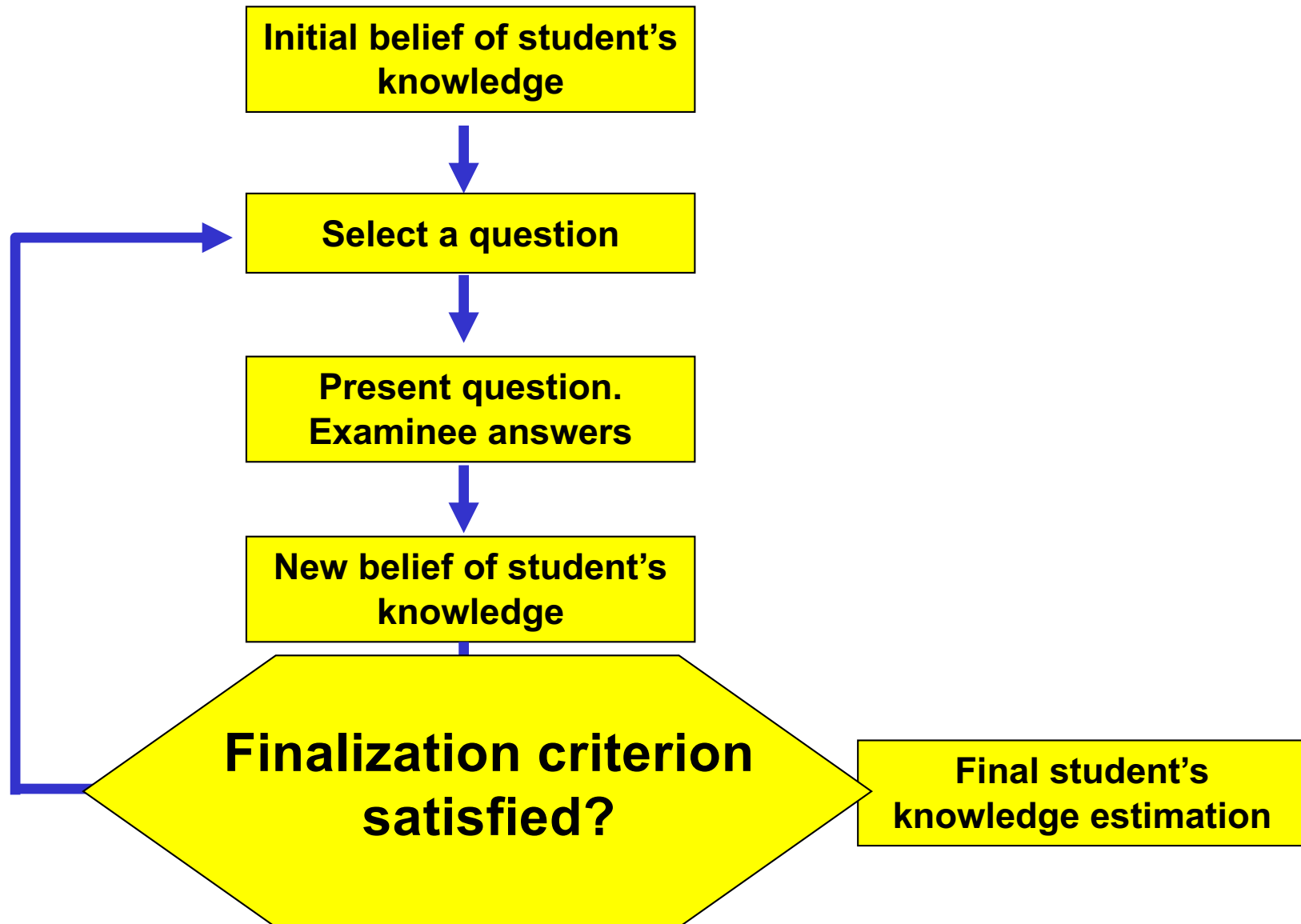
*Item Characteristic Curves for two questions*

# Selecting a question based on ICC's

	If correct response	If incorrect response
<p><b>Student's knowledge</b></p> <p><b>P(student's score=X)</b></p> <p><b>X</b></p>	<p><b>Hard question</b></p> <p><b>New student's knowledge</b></p> <p><b>0 1 2 3 4 5 6 7 8 9 10</b></p> <p><math>\sigma</math> <math>\sigma</math></p>	<p><b>Hard question</b></p> <p><b>New student's knowledge</b></p> <p><b>0 1 2 3 4 5 6 7 8 9 10</b></p> <p><math>\sigma</math> <math>\sigma</math></p>
<p><b>Easy question</b></p>	<p><b>Easy question</b></p> <p><b>New student's knowledge</b></p> <p><b>0 1 2 3 4 5 6 7 8 9 10</b></p> <p><math>\sigma</math> <math>\sigma</math></p>	<p><b>Easy question</b></p> <p><b>New student's knowledge</b></p> <p><b>0 1 2 3 4 5 6 7 8 9 10</b></p> <p><math>\sigma</math> <math>\sigma</math></p>

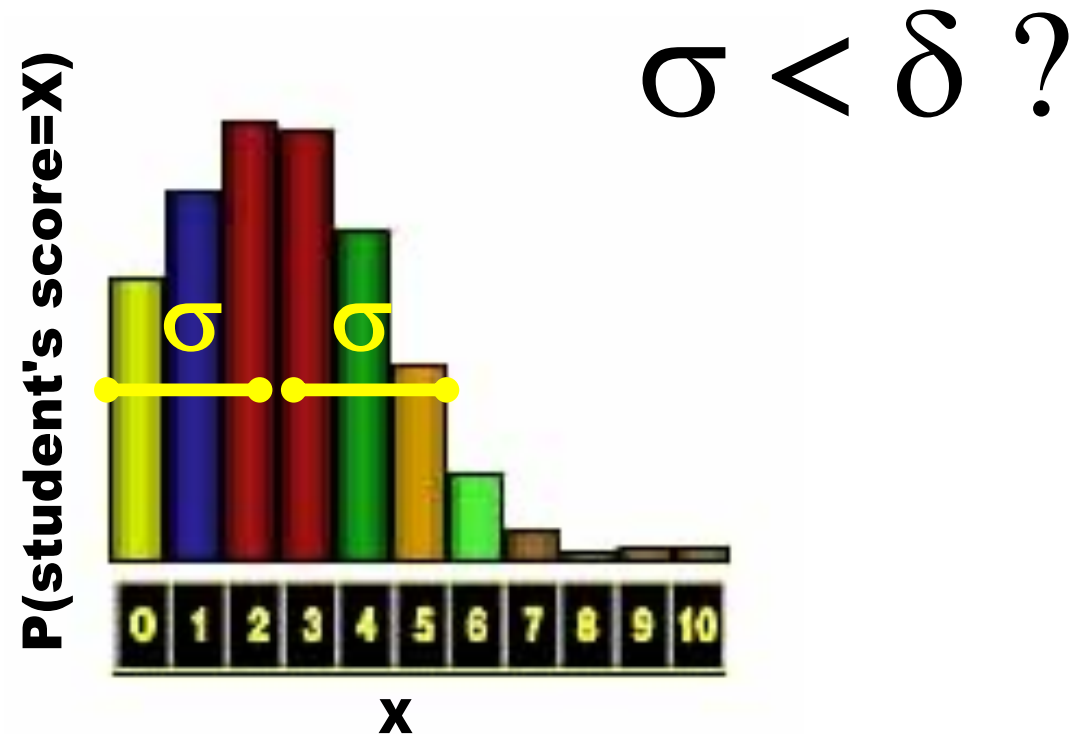


# Computer Adaptive Testing



# Finalization criterion satisfied?

- Are we confident enough about the student's knowledge estimation?



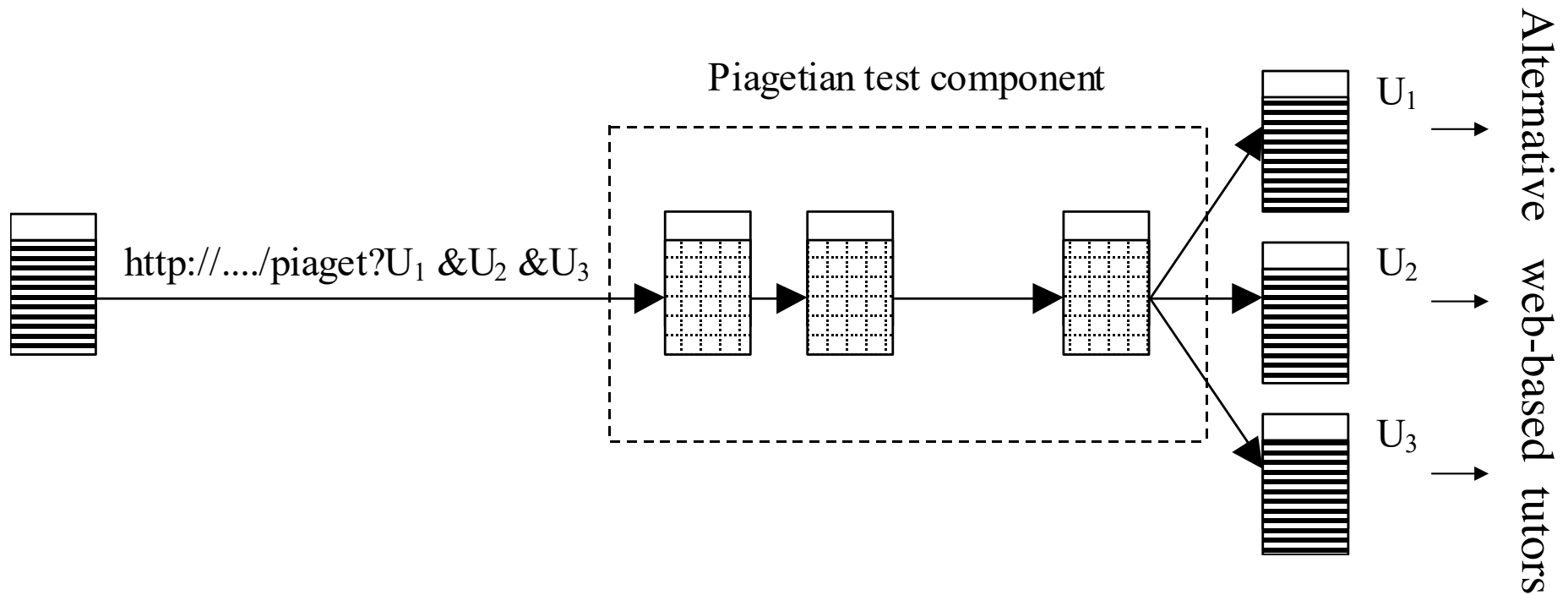
# Some problems of each area

- Adapting ITS behavior to learner traits:
  - Diagnosis can become a long process.
  - The objective is tutoring, not pre-testing.
- Adaptive testing:
  - No reusable adaptive testing components available
  - Tests consist only of multiple choice quizzes

# Aiding each other for better ITS

- Adapting ITS behavior to learner traits:
  - Use adaptive testing for diagnosis
- Adaptive testing:
  - Make it reusable for any web-based ITS
  - Extend testing abilities by including applets
  - Instantiate it with some learner traits test

# Integrating the cognitive development test and SIETTE



# SIETTE: An adaptive testing system

- Web-based

- Adaptive

  - Computerized Adaptive Testing

  - Item Response Theory

- Multiple-choice based

SIETTE

Sistema Inteligente de Evaluación mediante Test

para la TeleEducación.

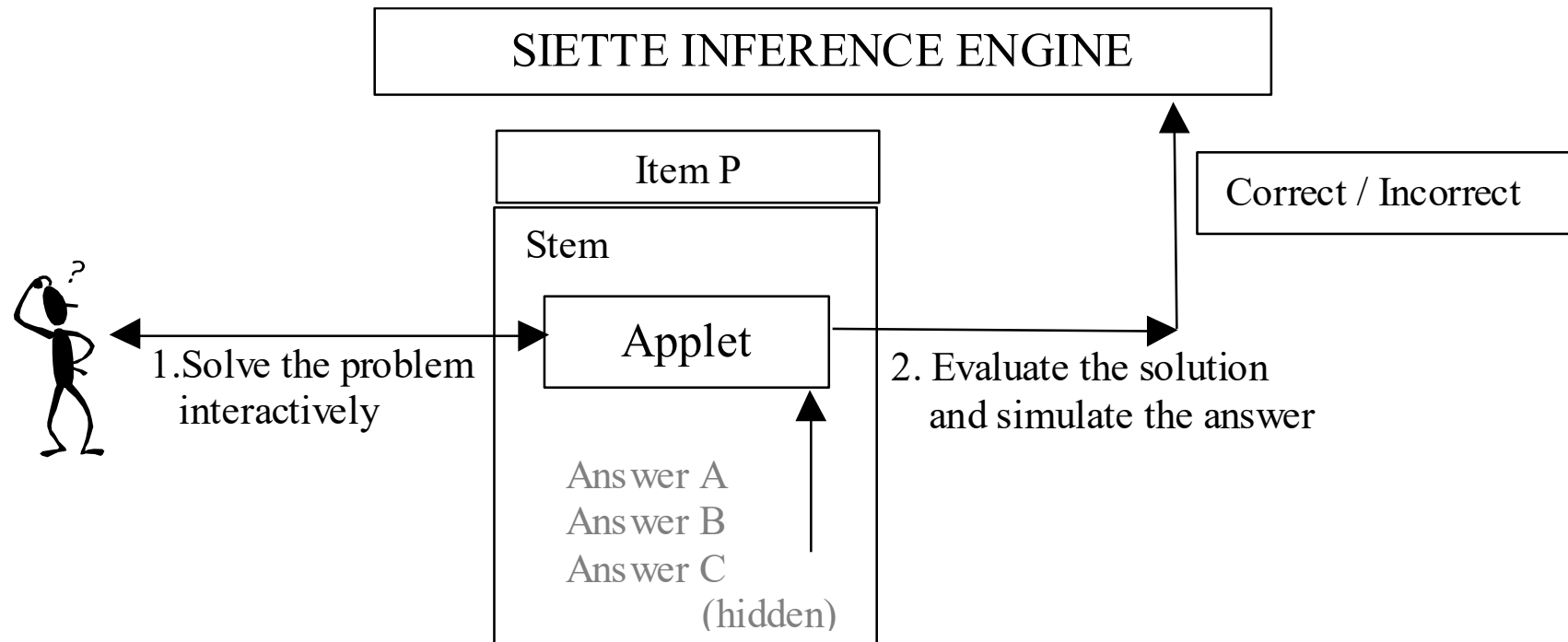


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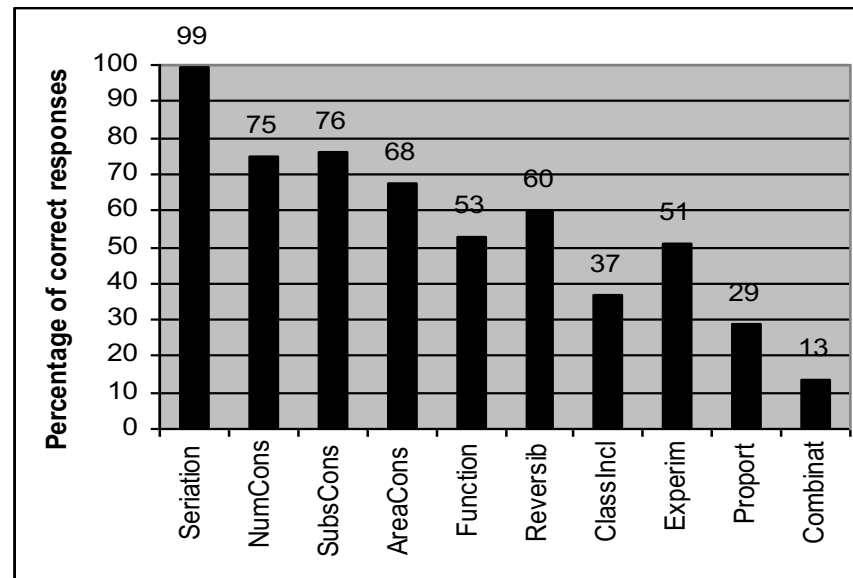


# SIETTE: Evaluation with applets



# Integrating the Piaget test and Siette

- Analyzed responses of 150 children, 8-11 year olds.

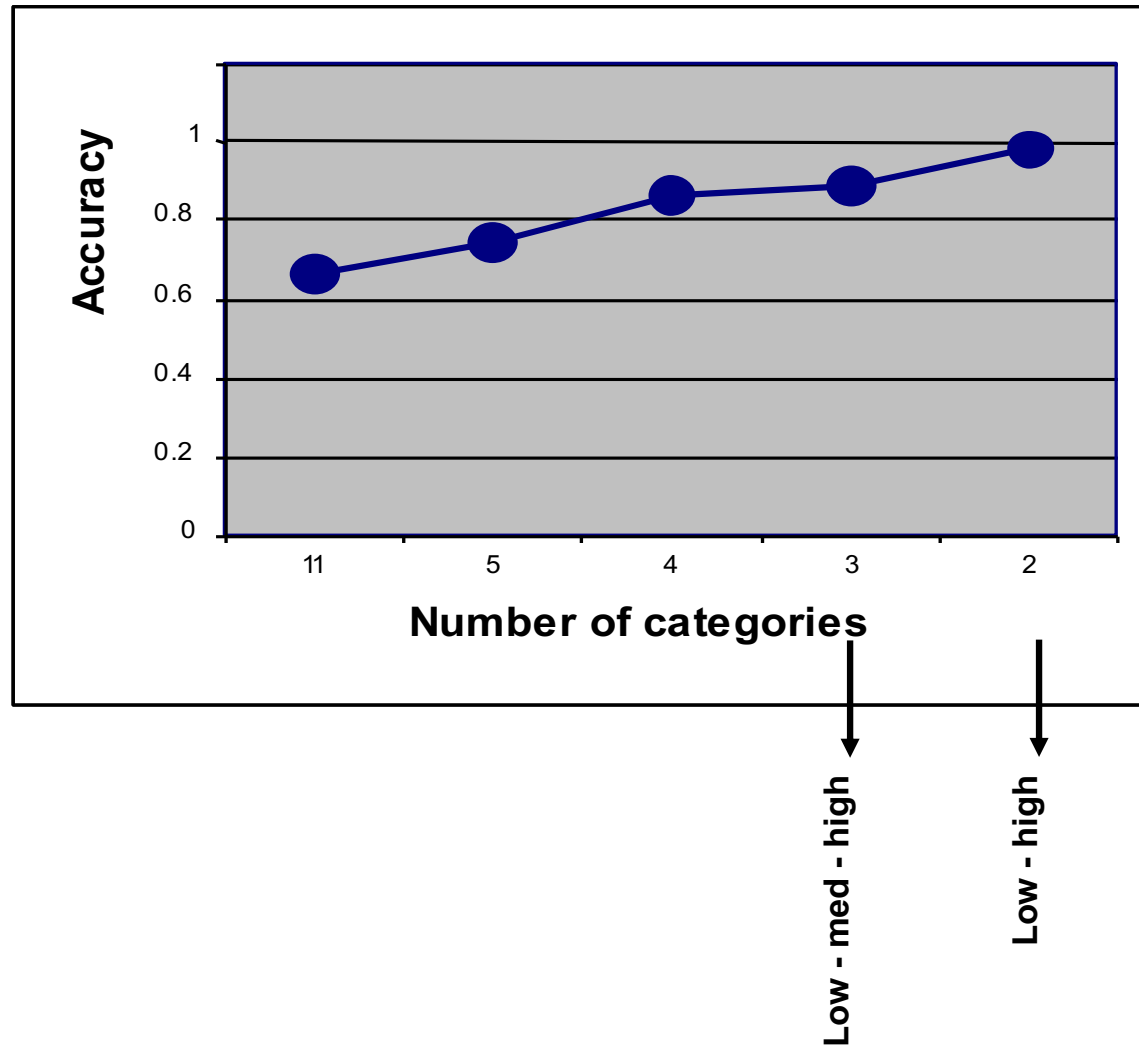


- Built ICCs from 100 cases, using an off-line simulator
- Saved the remaining 50 cases for accuracy testing



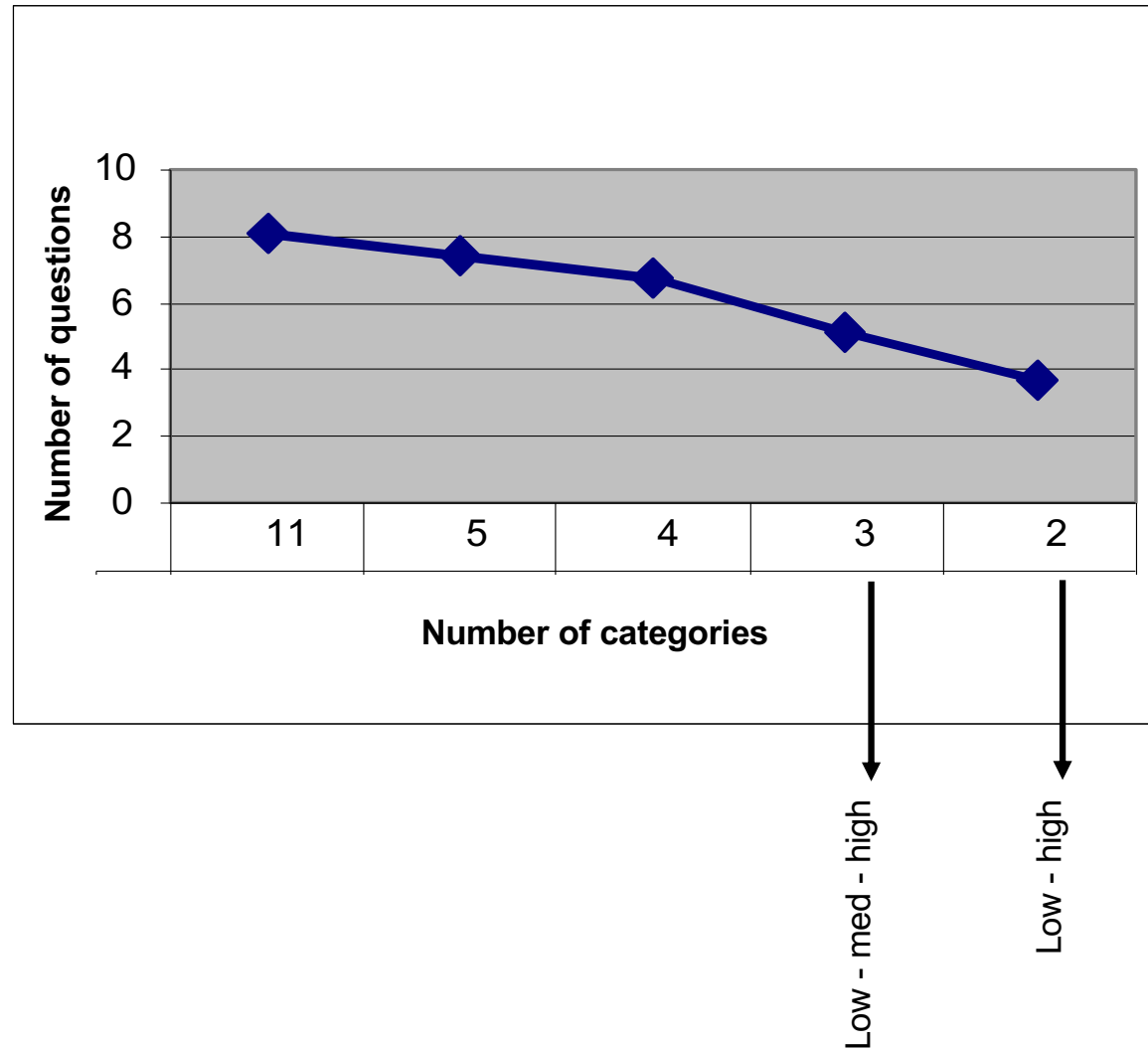
# Accuracy of the adaptive test

Accuracy of the adaptive and non-adaptive test



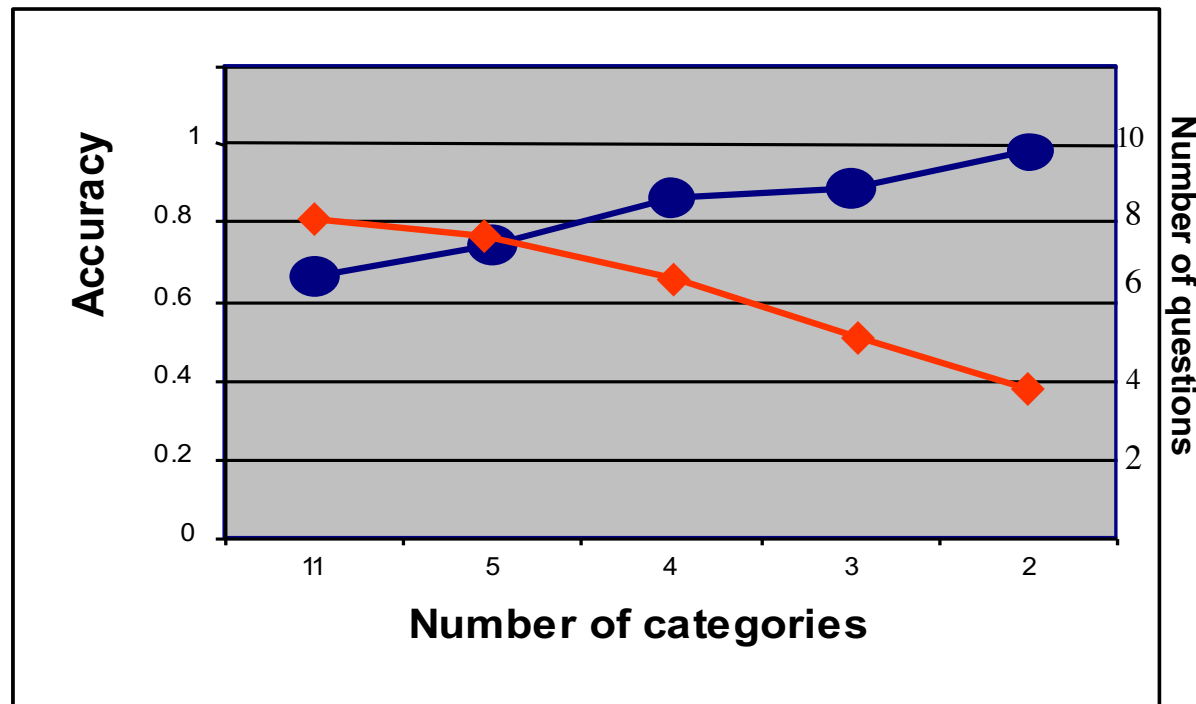
# Behavior of the adaptive test

Average number of questions per number of categories



# Accuracy and behavior of the adaptive test

- Accuracy of the adaptive test
- Average number of questions per number of categories



# Summary

- A web-based adaptive testing system
  - Allows interactivity in testing
  - It allows for macro-adaptation
- We instantiated it with a cognitive test
  - For 8-11 year olds
  - The Adaptive Test...
    - ...reduces test time
    - ...keeping the accuracy

# Conclusions

- Adaptive testing and ITS are complementary
- Web-based architecture allows for reusability
  - of SIETTE
  - of this cognitive development test
- We can use IRT/CAT to test more than multiple choices.
- Adaptive testing simplifies macro-adaptation