An Adaptive Web-based Component for Cognitive Ability Estimation

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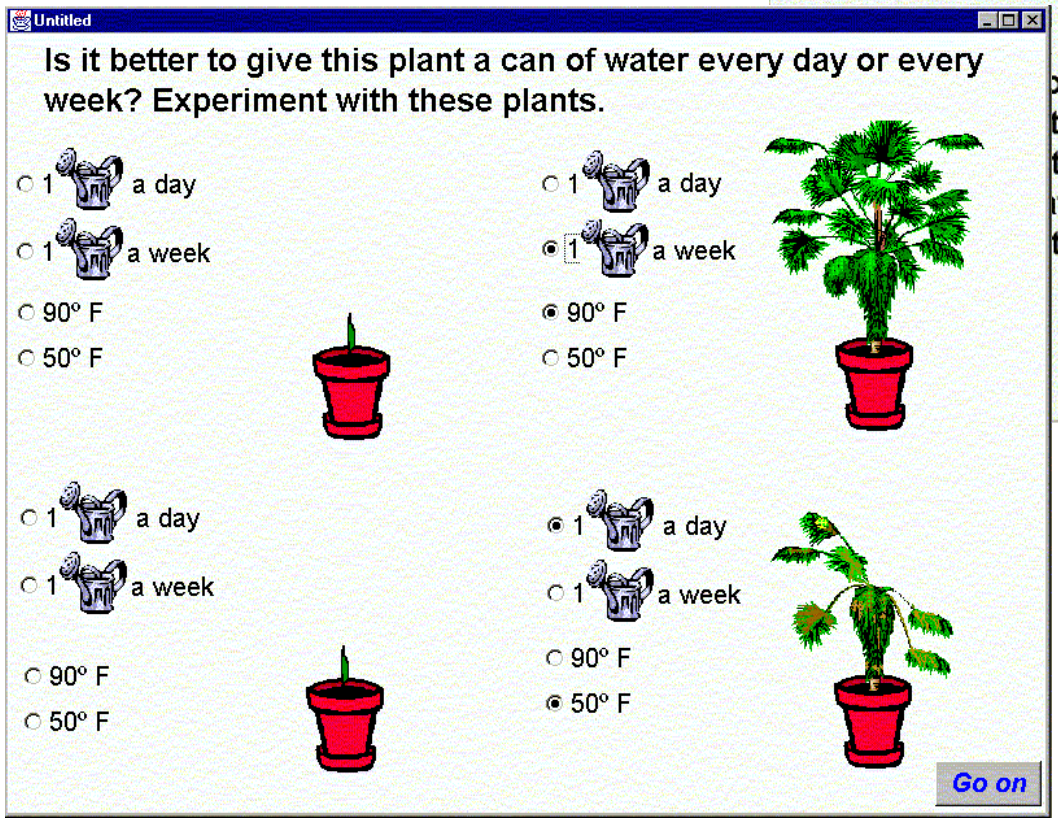
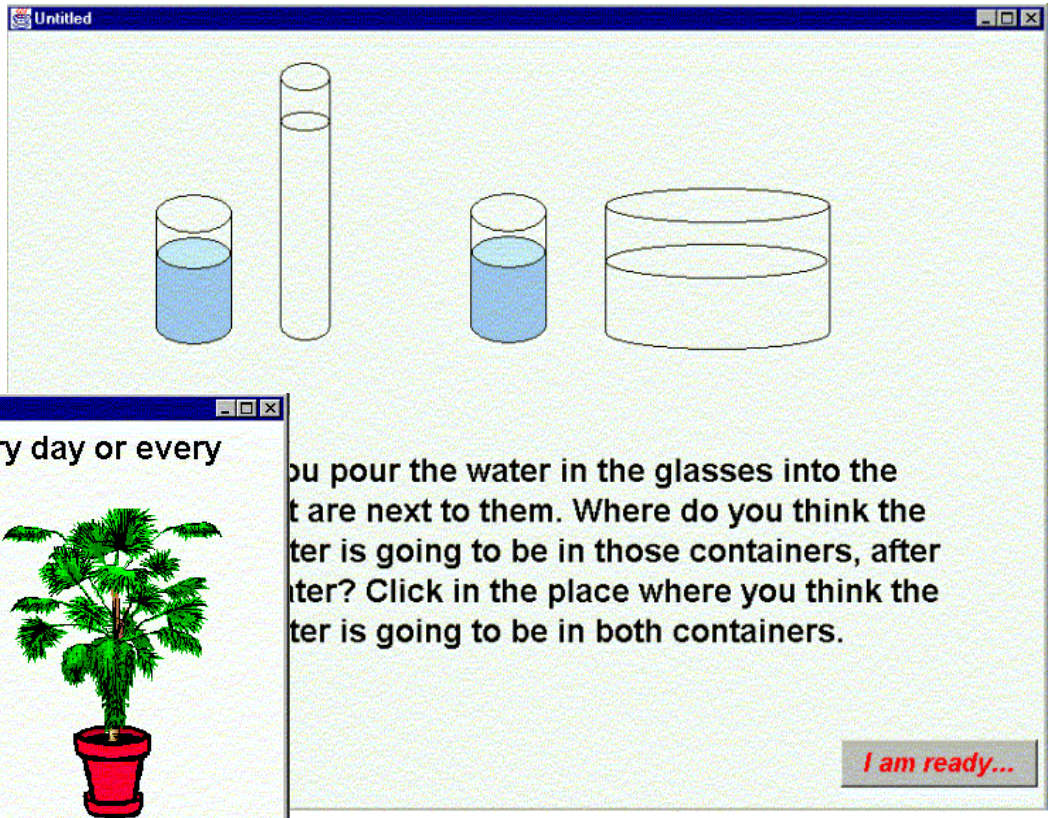
Two different areas of research

- 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



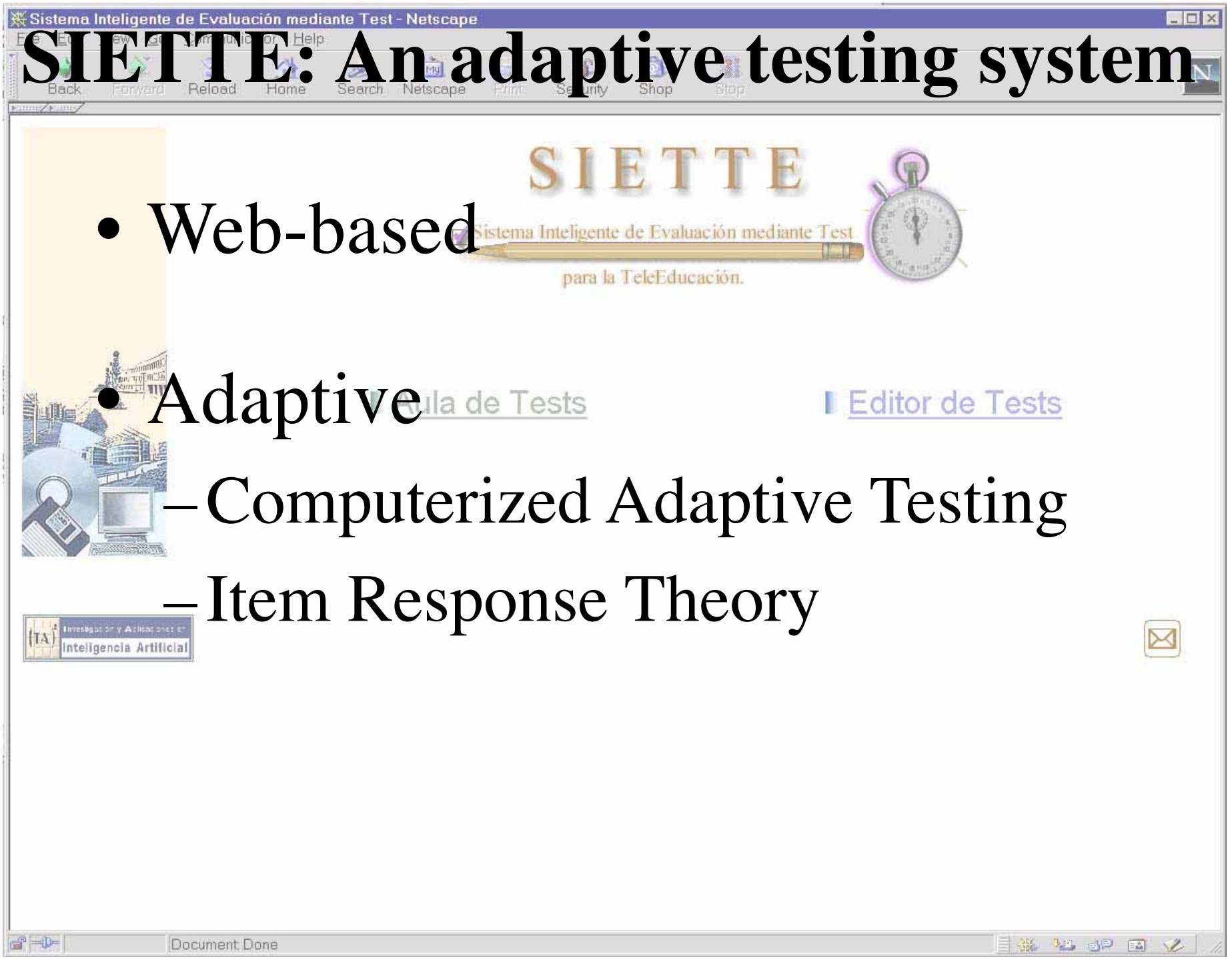


Concrete thinking

Validity and reliability

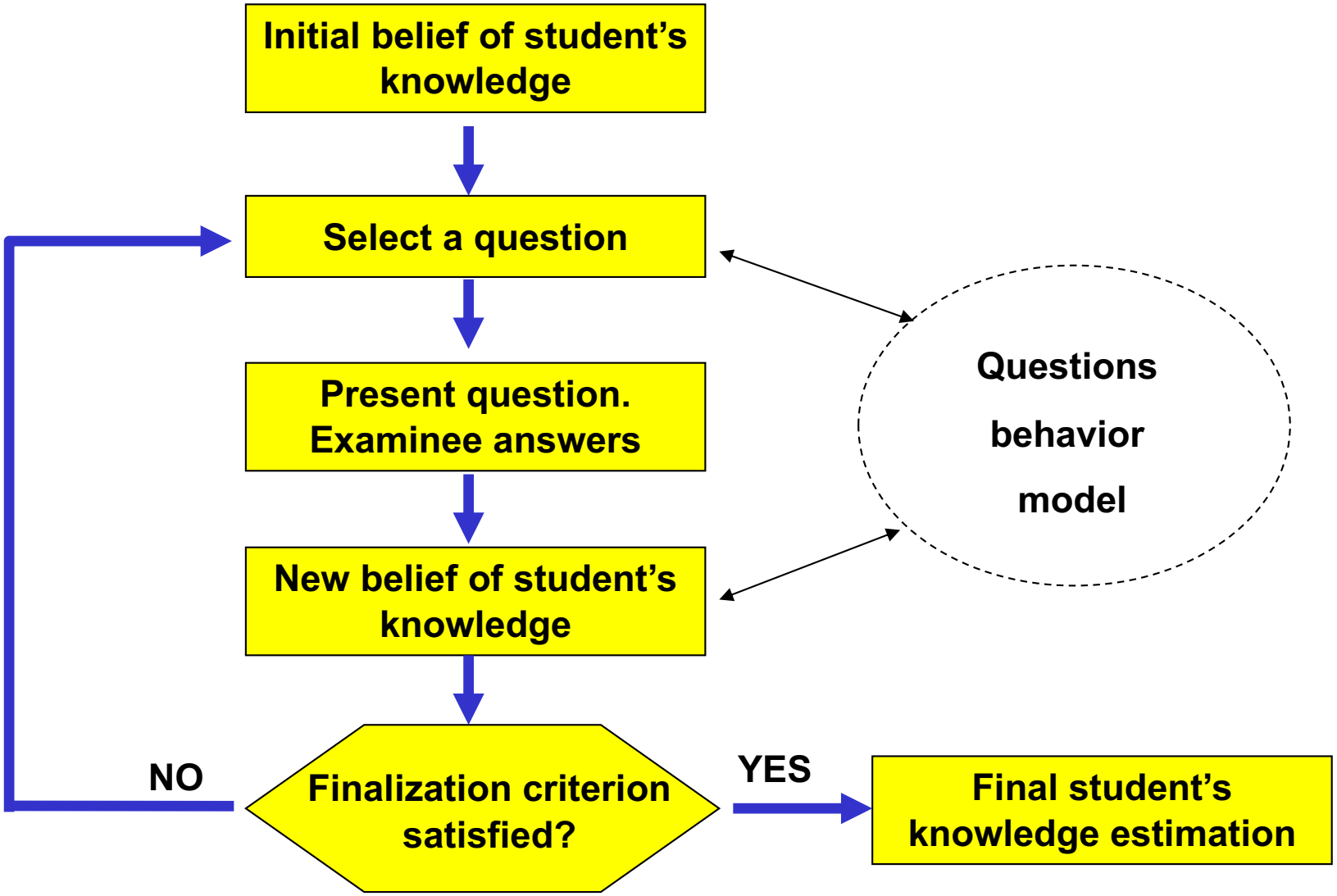
- Good at predicting math performance and time.
- Students succeed at concrete tasks more
- Built with an expert in Piaget psychology
- Reliable (take and re-take of test)
- Cognitive development x hint symbolism determines performance in an ITS

SIETTE: An adaptive testing system



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

Computer Adaptive Testing



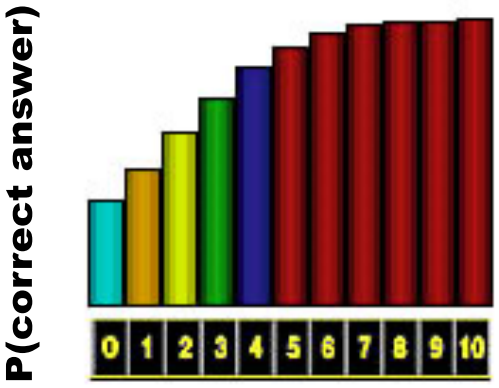
Questions behavior model
10 question test

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

Prior full-test-taker responses

…

ICC for an easy question



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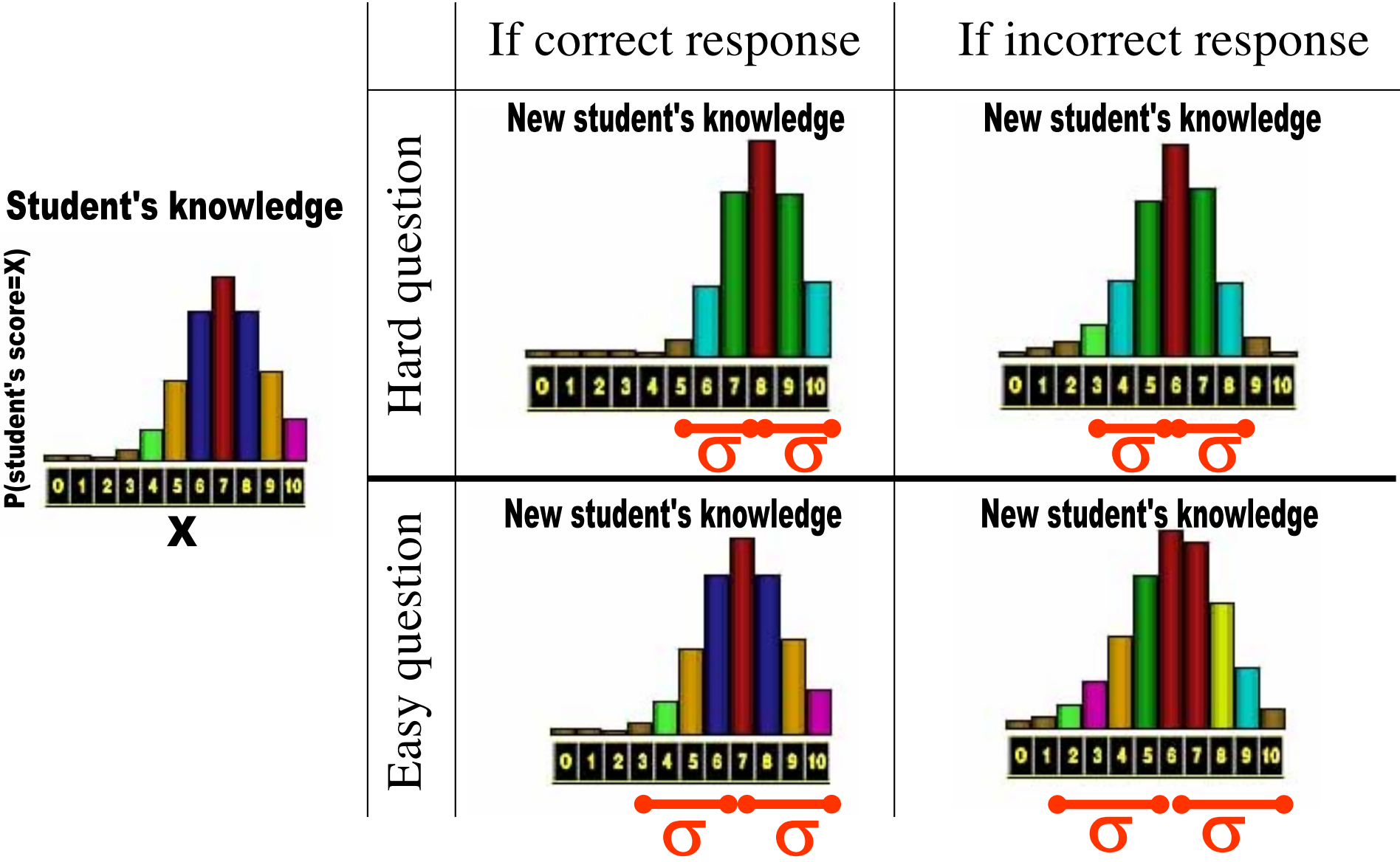
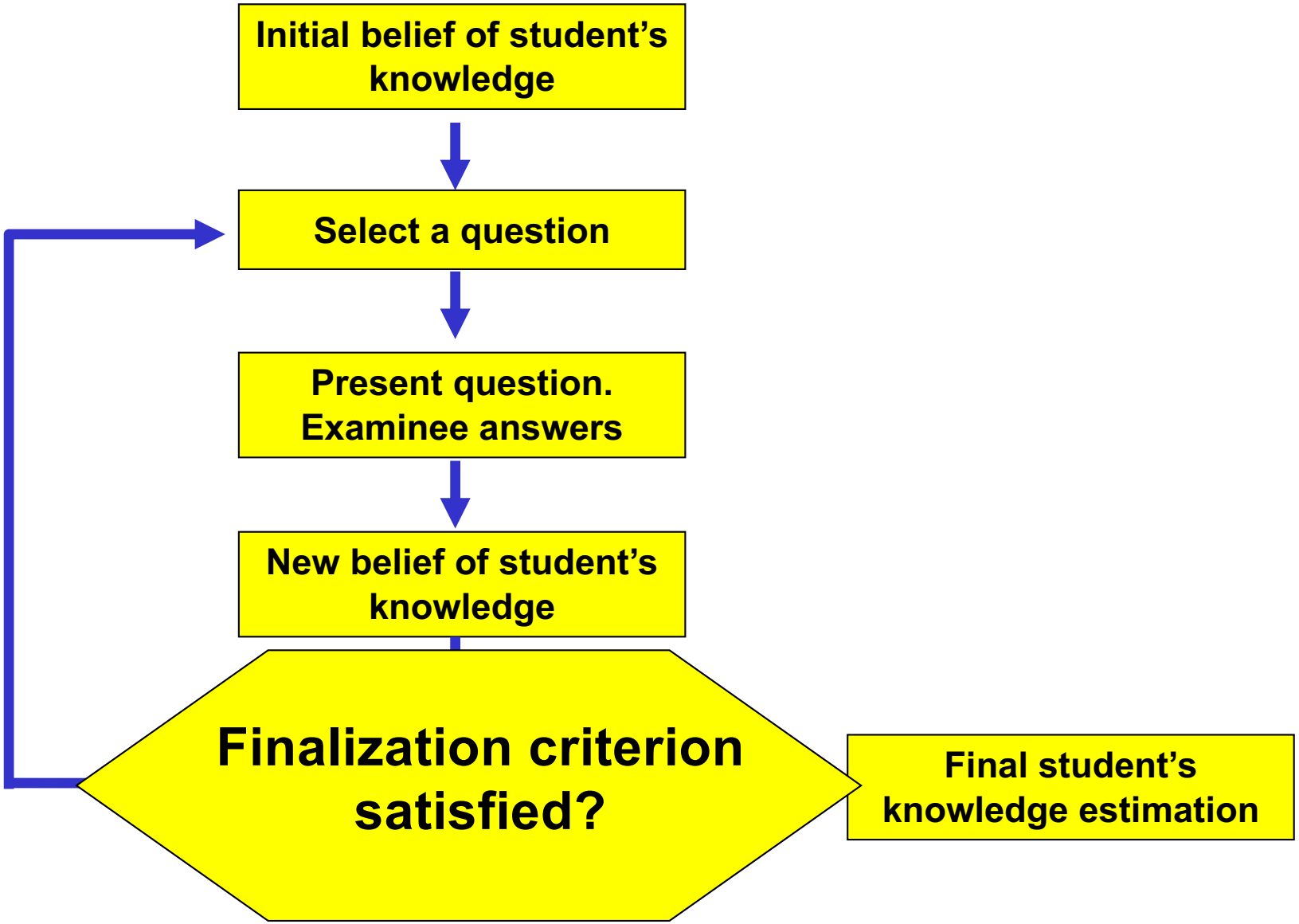
ICC for a hard question

Item Characteristic Curves for two questions

Selecting a question based on ICC's



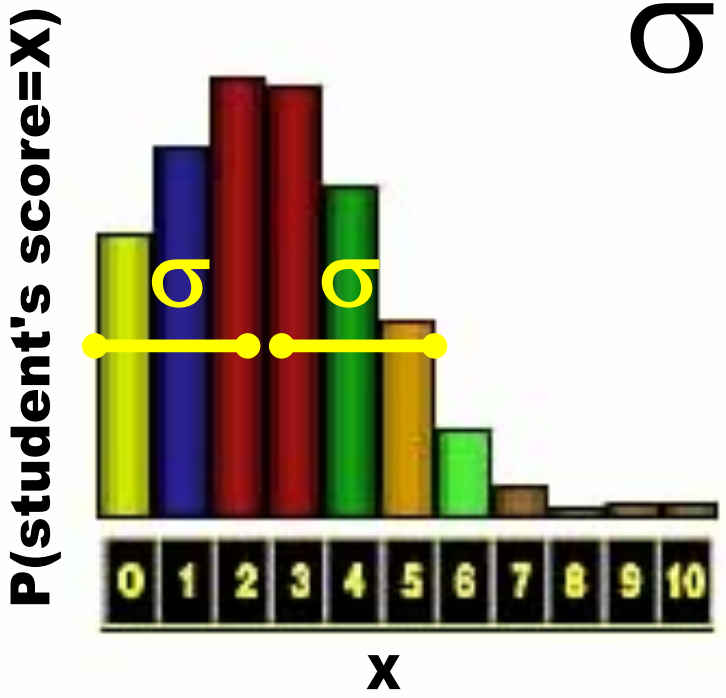
Computer Adaptive Testing



Finalization criterion satisfied?

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

$$\sigma < \delta \ ?$$



Some problems of each area

- Adapting ITS behavior to learner traits:
  - Diagnosis can become a long process.
  - The objective is tutoring, not pre-testing.

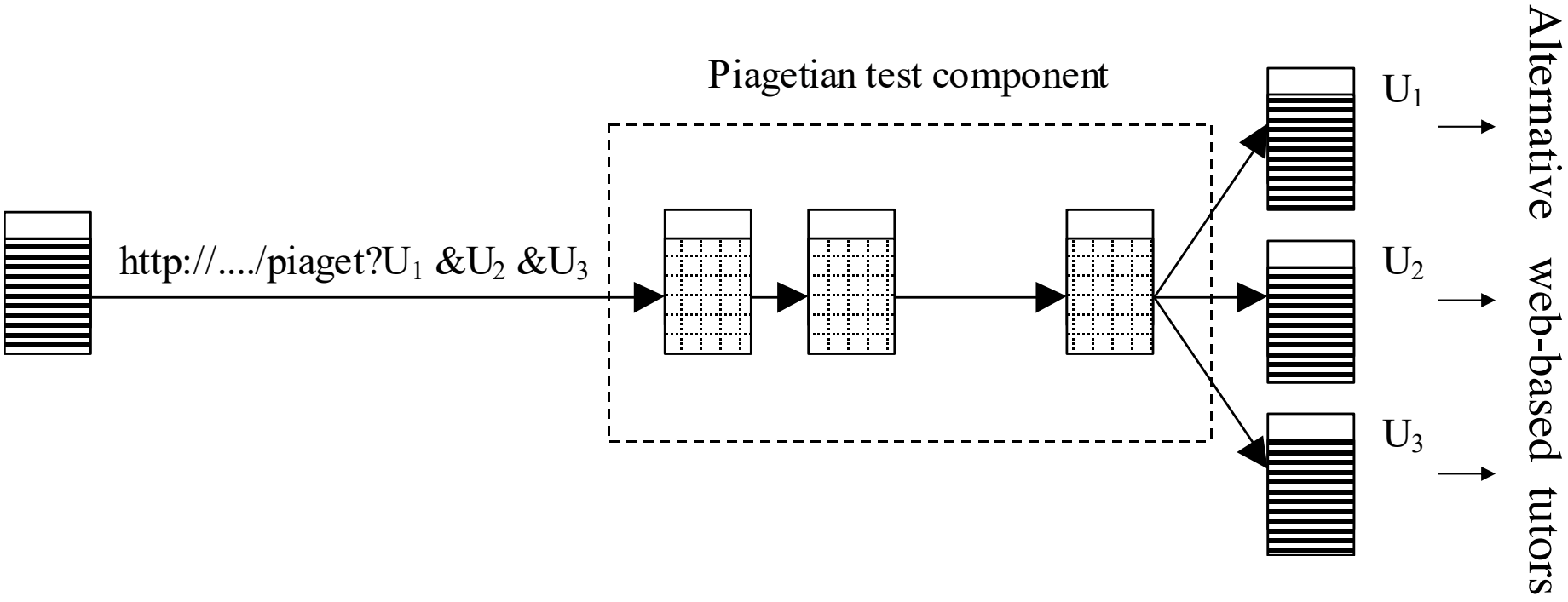
- Adaptive testing:
  - No reusable adaptive testing components available
  - Tests consist only of multiple choice quizzes

Aiding each other for better ITS

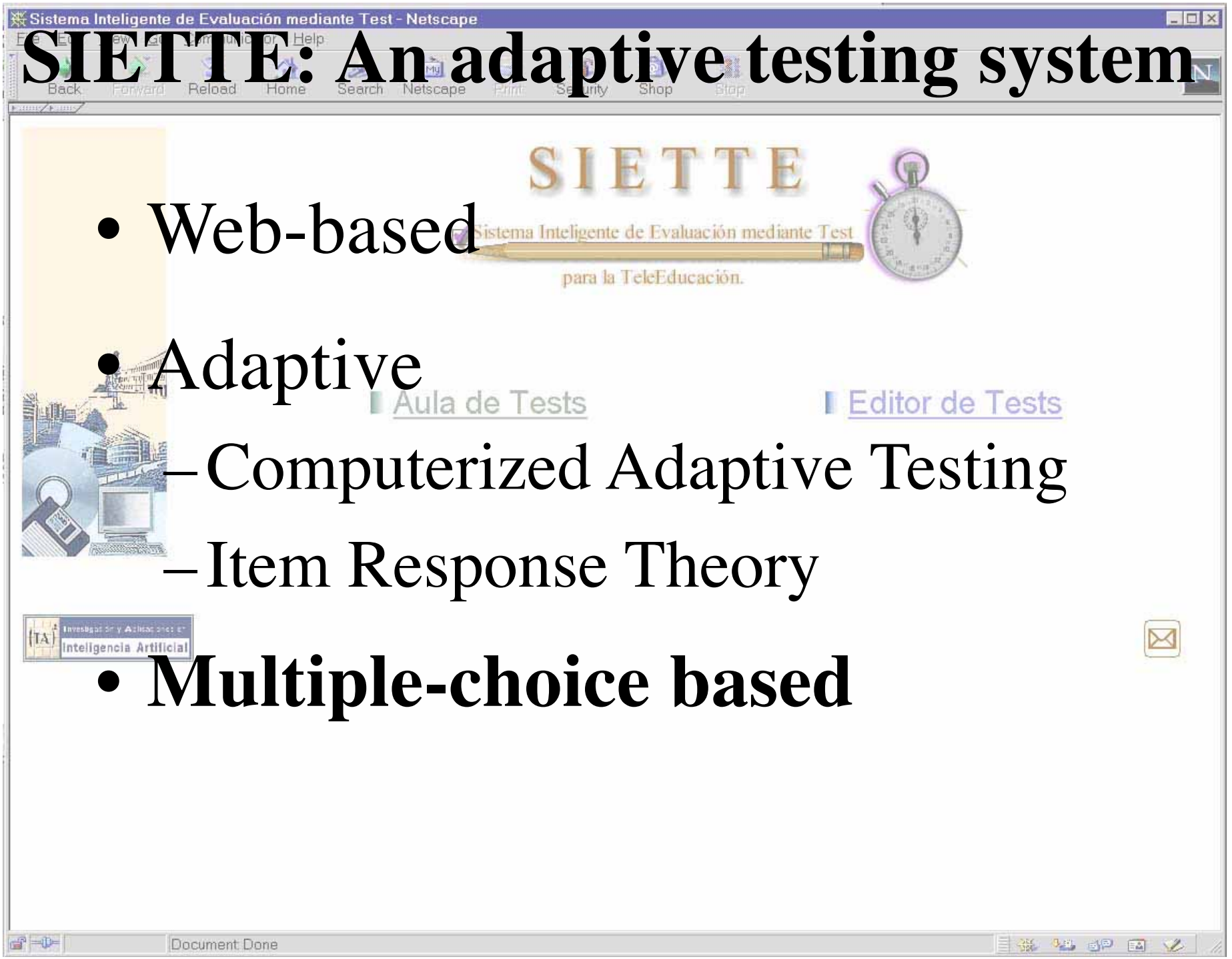
- Adapting ITS behavior to learner traits:
  - Use adaptive testing for diagnosis

- 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

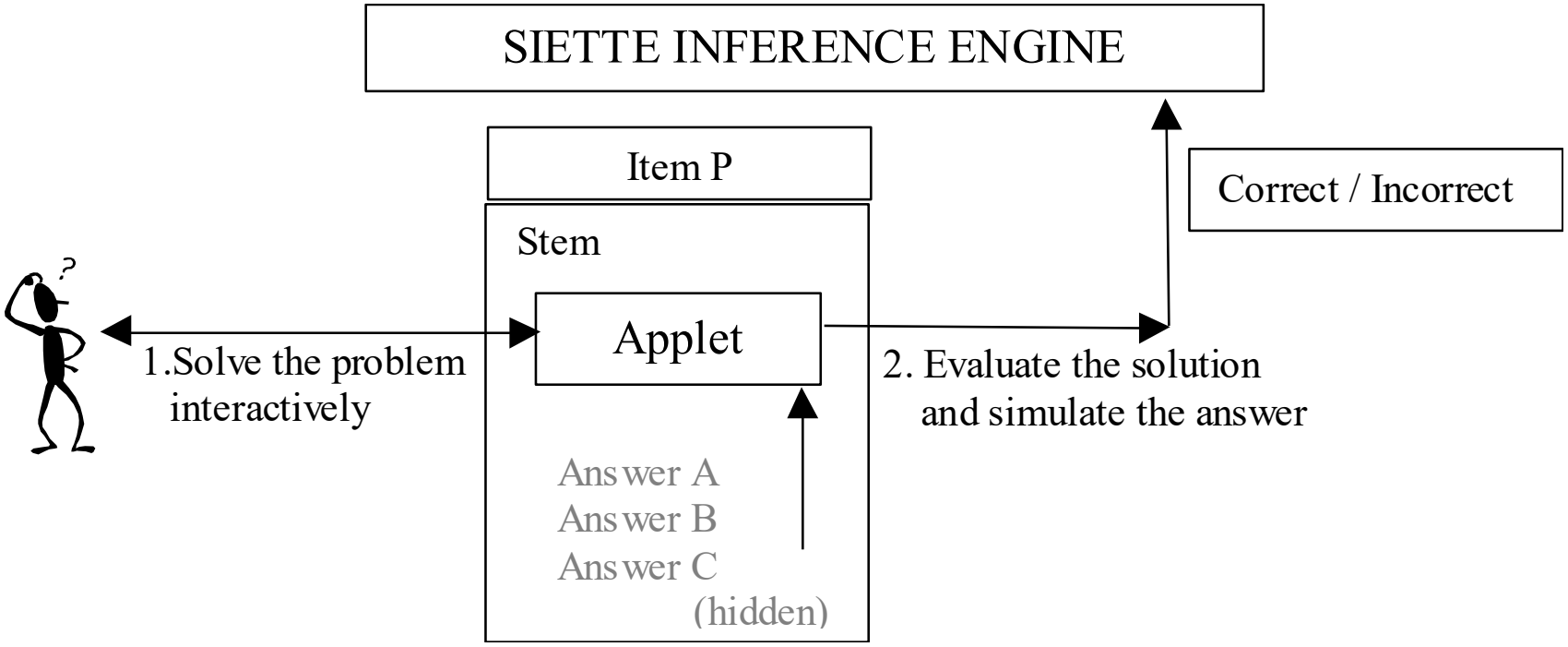


SIETTE: An adaptive testing system



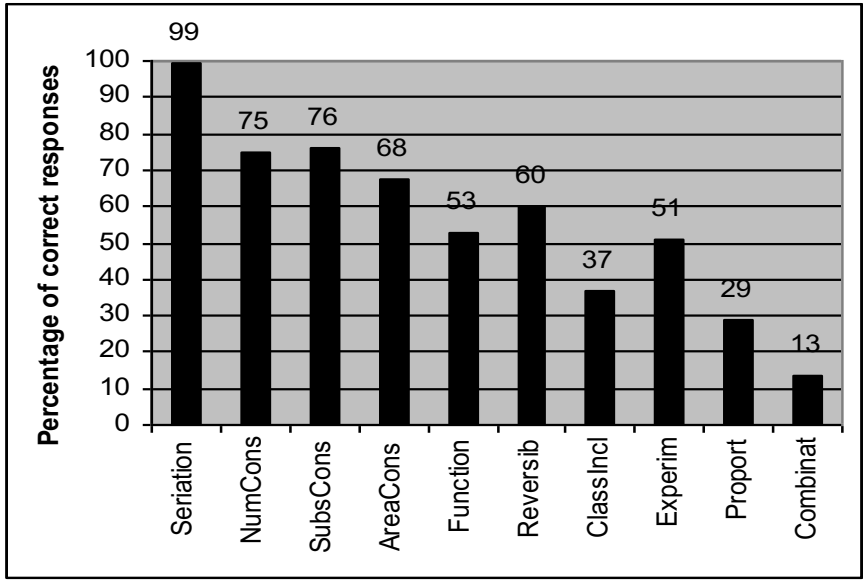
- Web-based
- Adaptive
  - Computerized Adaptive Testing
  - Item Response Theory
- **Multiple-choice based**

SIETTE: Evaluation with applets



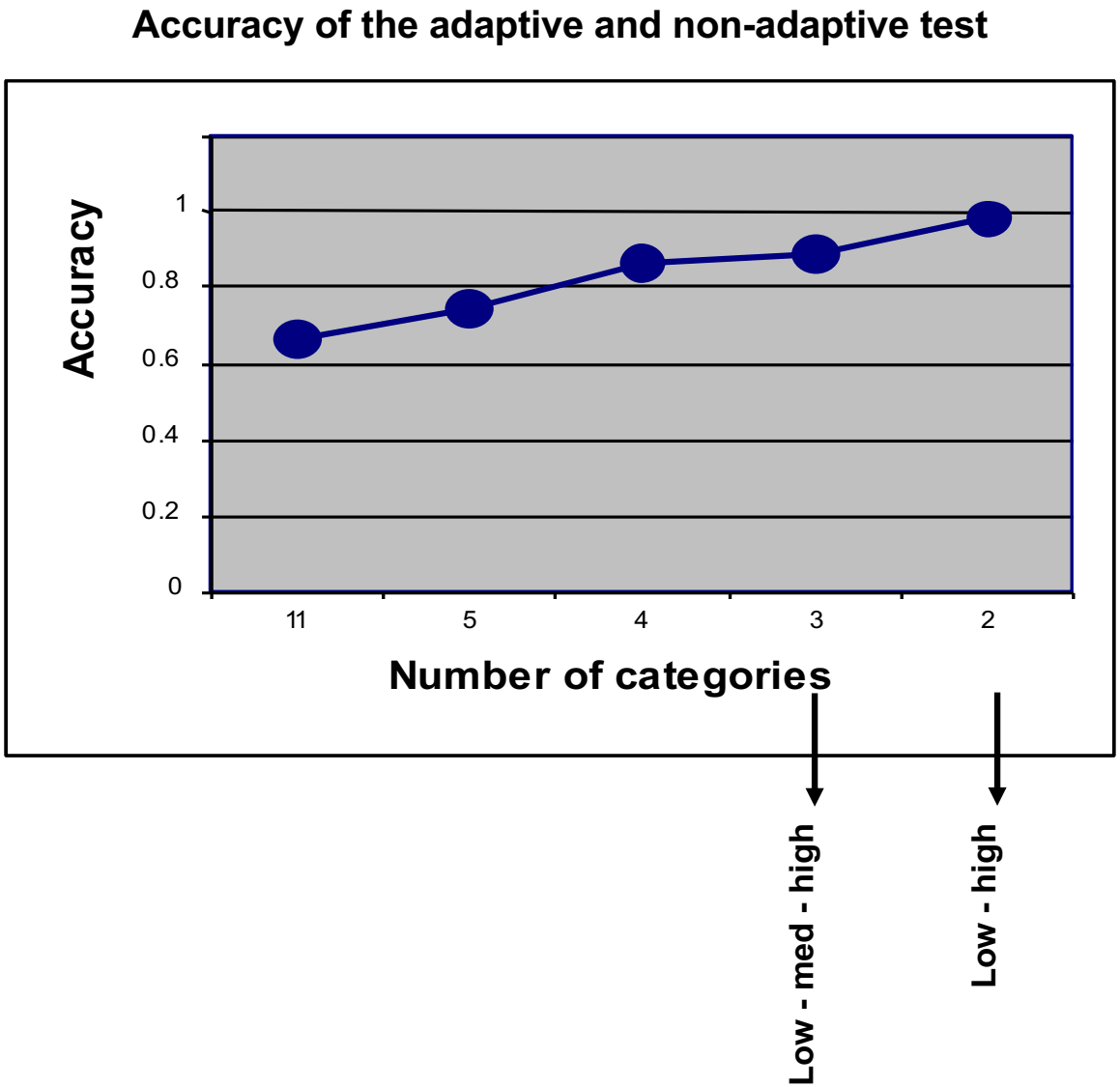
Integrating the Piaget test and Siette

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

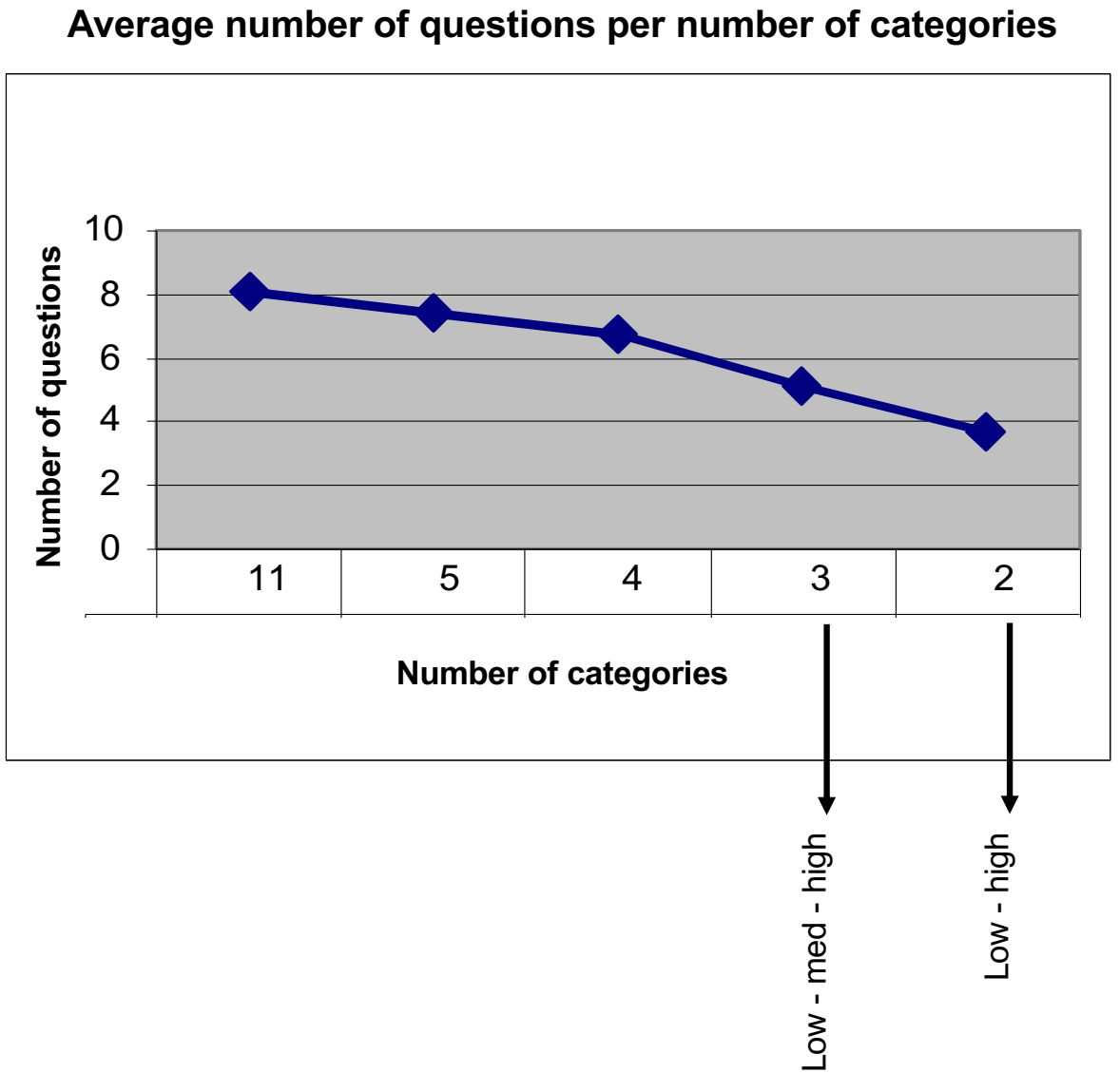


- Built ICCs from 100 cases, using an off-line simulator
- Saved the remaining 50 cases for accuracy testing

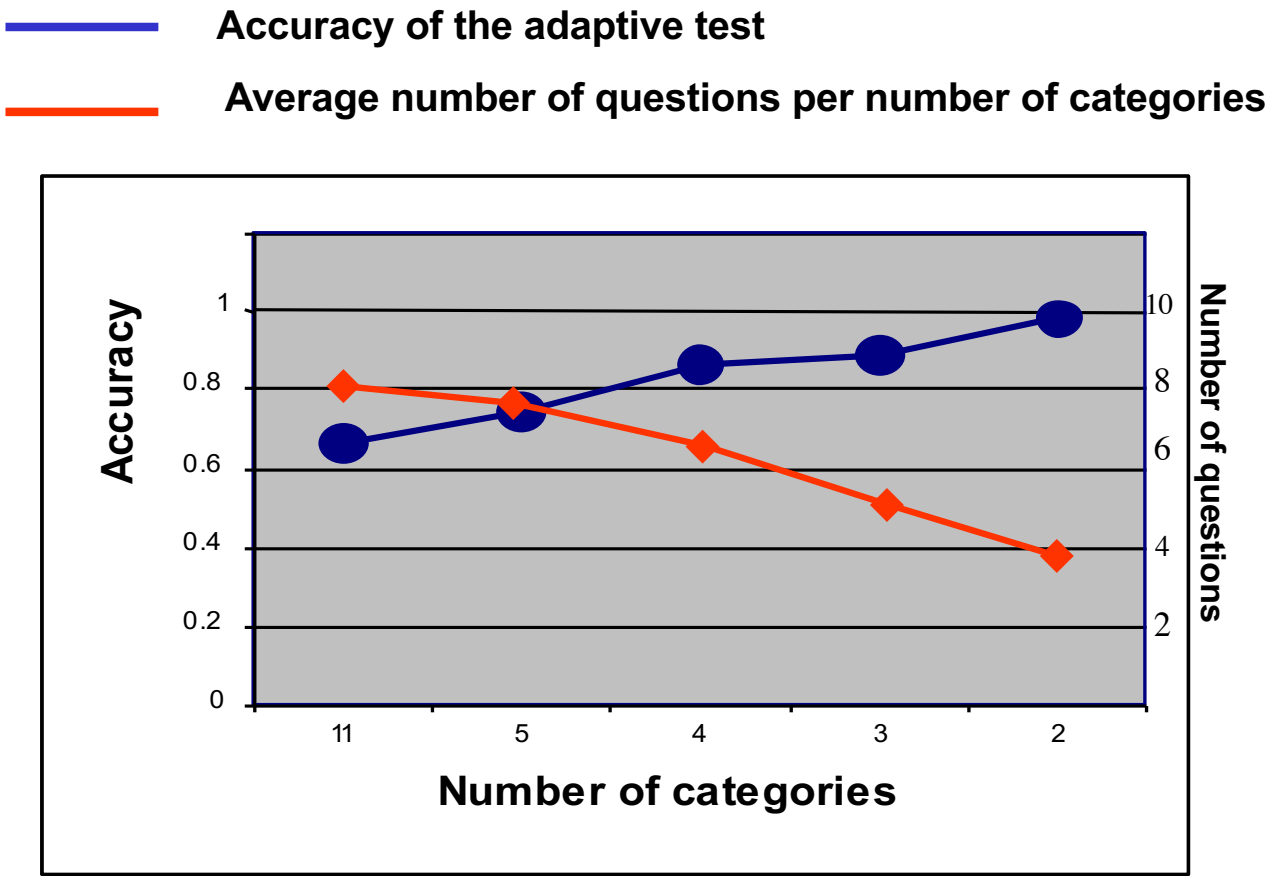
Accuracy of the adaptive test



Behavior of the adaptive test



Accuracy and behavior of the adaptive test



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