ICME-TSG 13
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Concrete to Abstract in a Grade 5/6 Class

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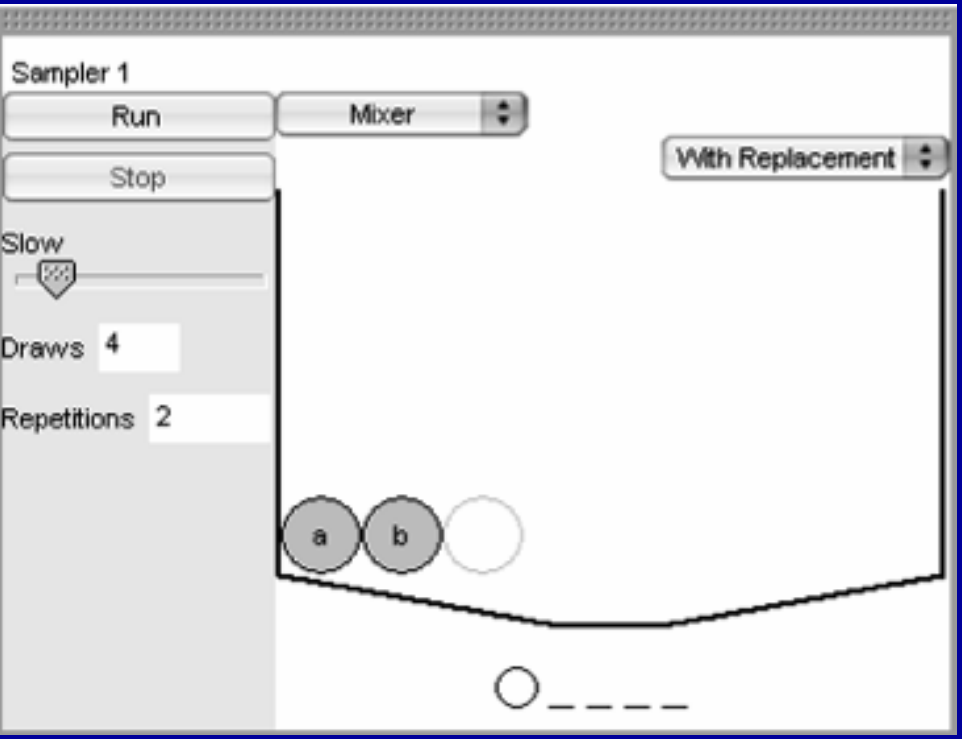
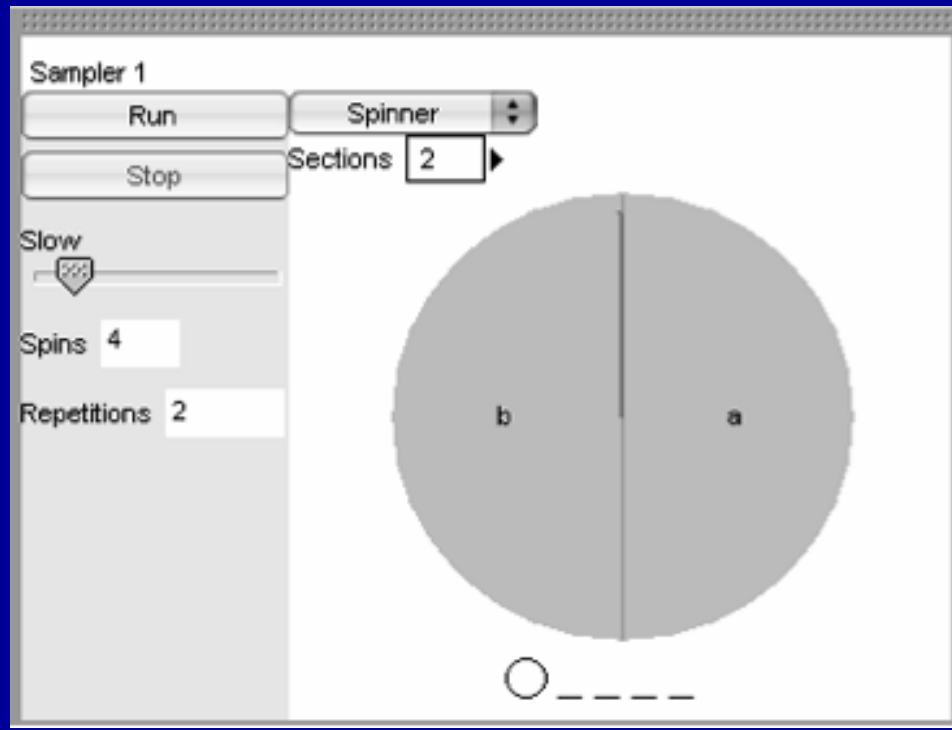
Ingredients in the Research

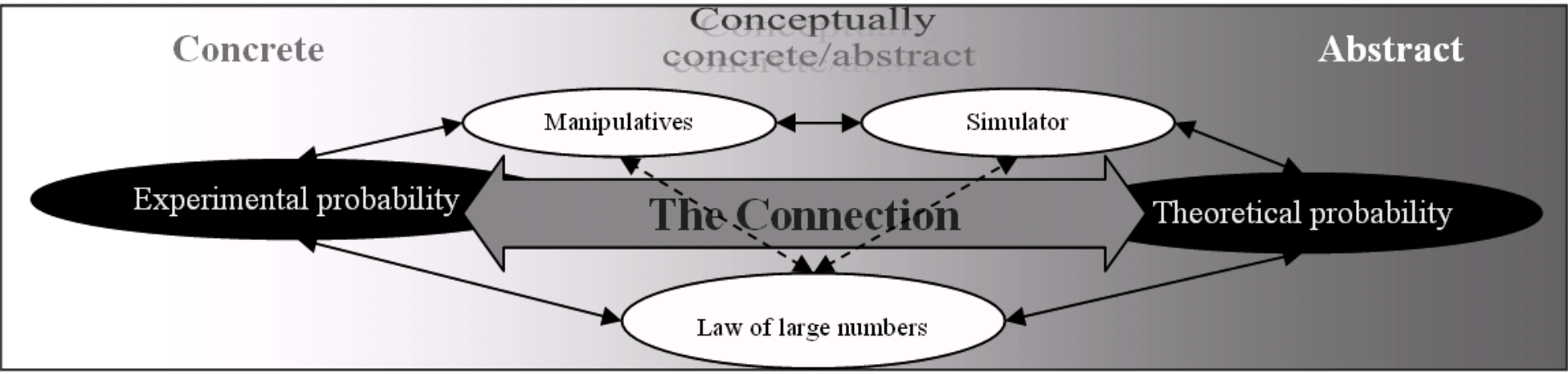
- Interest in ICT in the classroom to enhance learning
- Graham Jones' call for research on students' connections between classical and frequentist probability
- Availability of *TinkerPlots* Sampler
- A grade 5/6 with interested teacher willing to work with student researcher

The Mixer and the Spinner in *TinkerPlots* Sampler





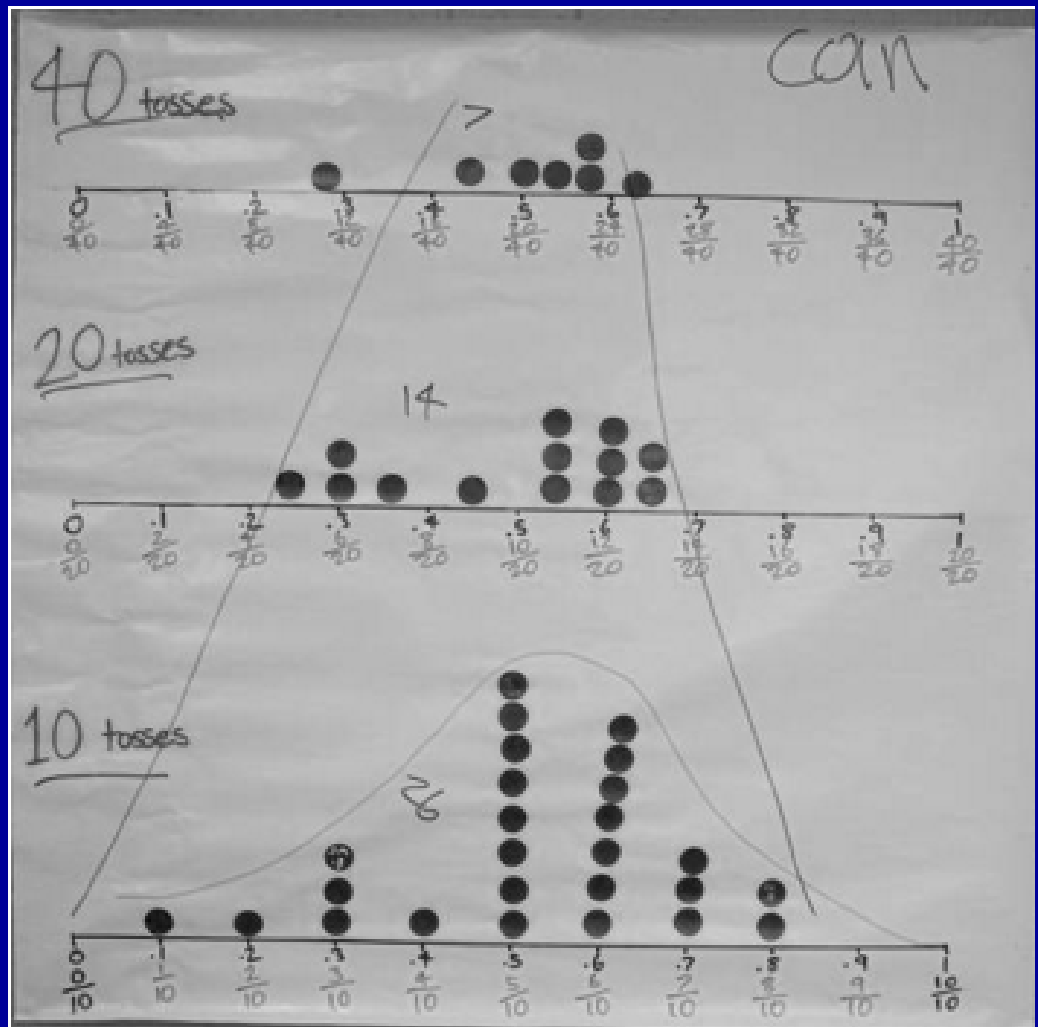
Concrete to Abstract conceptual framework



Lesson 1 with 27 Grade 5/6 Students

- Structured discussion of probability
  - events
  - chance phrases
  - “random”, “variation”
- Coin tossing
  - 10 trials
  - theoretical probability (“half”)
  - experimental probability
  - students tossing 10 times, recording
  - combining results

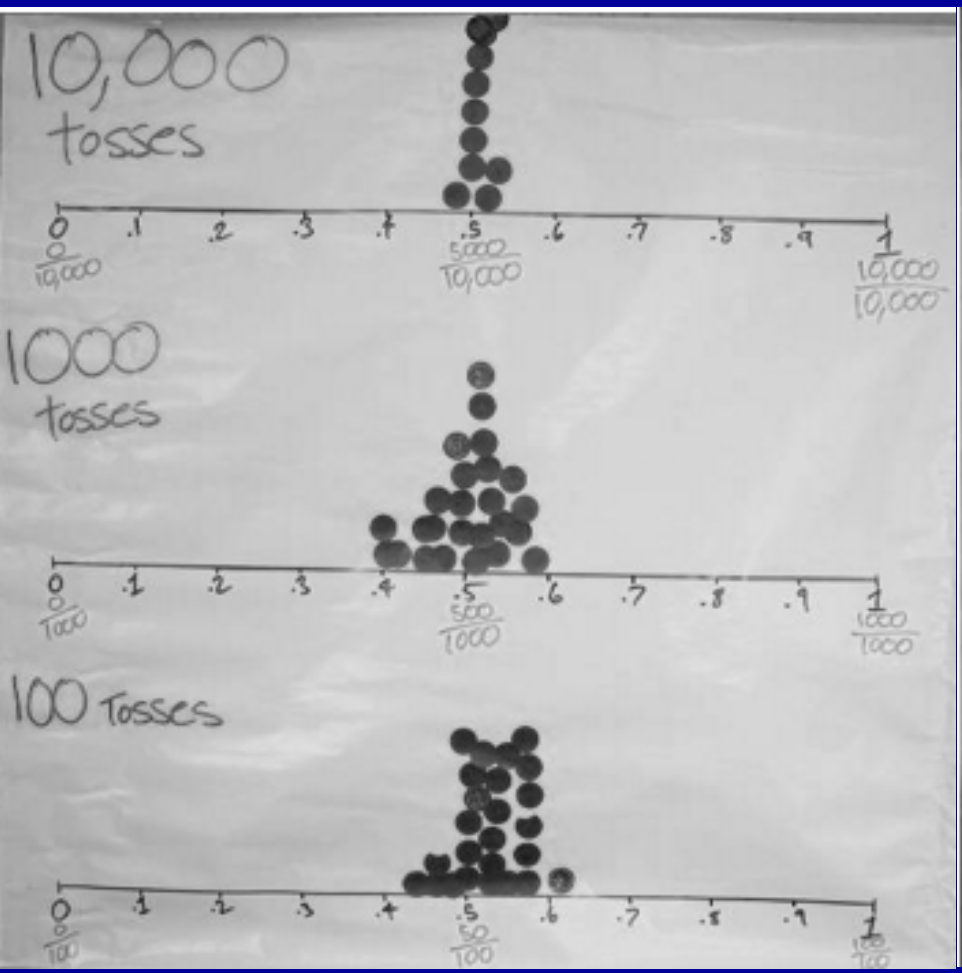
Tracking the tossing of a coin by students

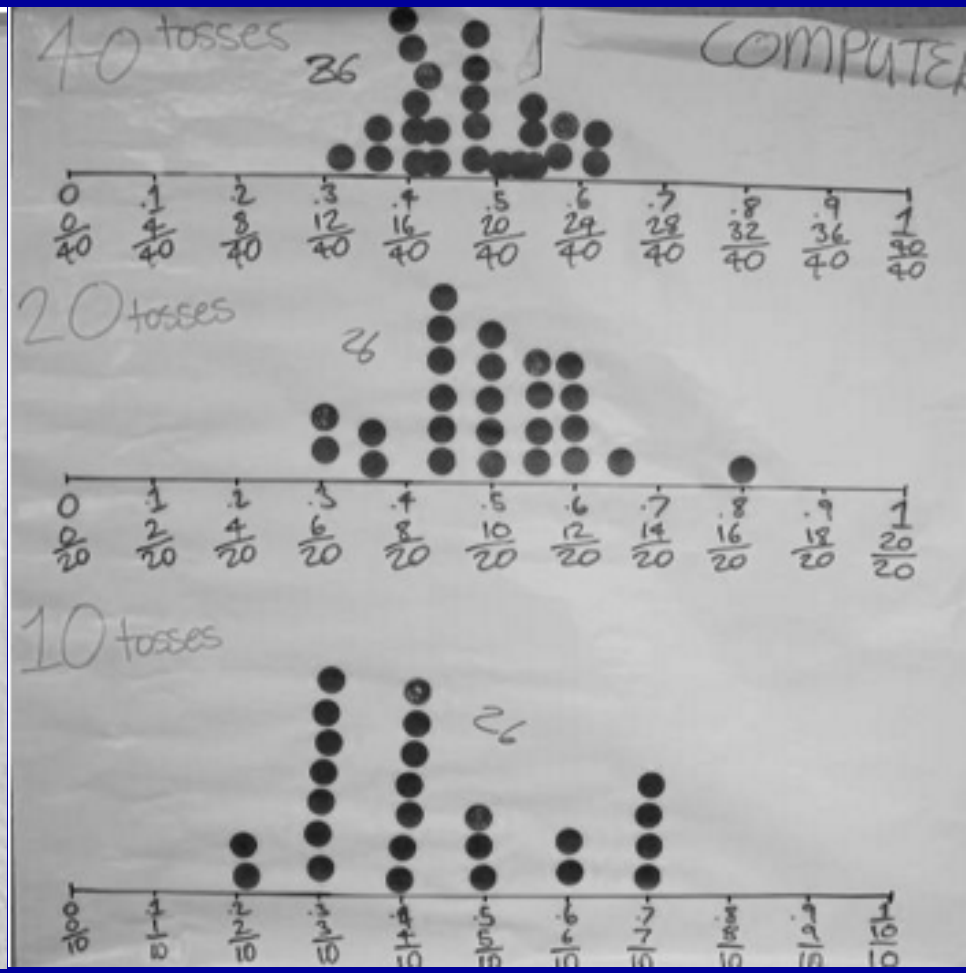


Lesson 2 with 27 Grade 5/6 Students

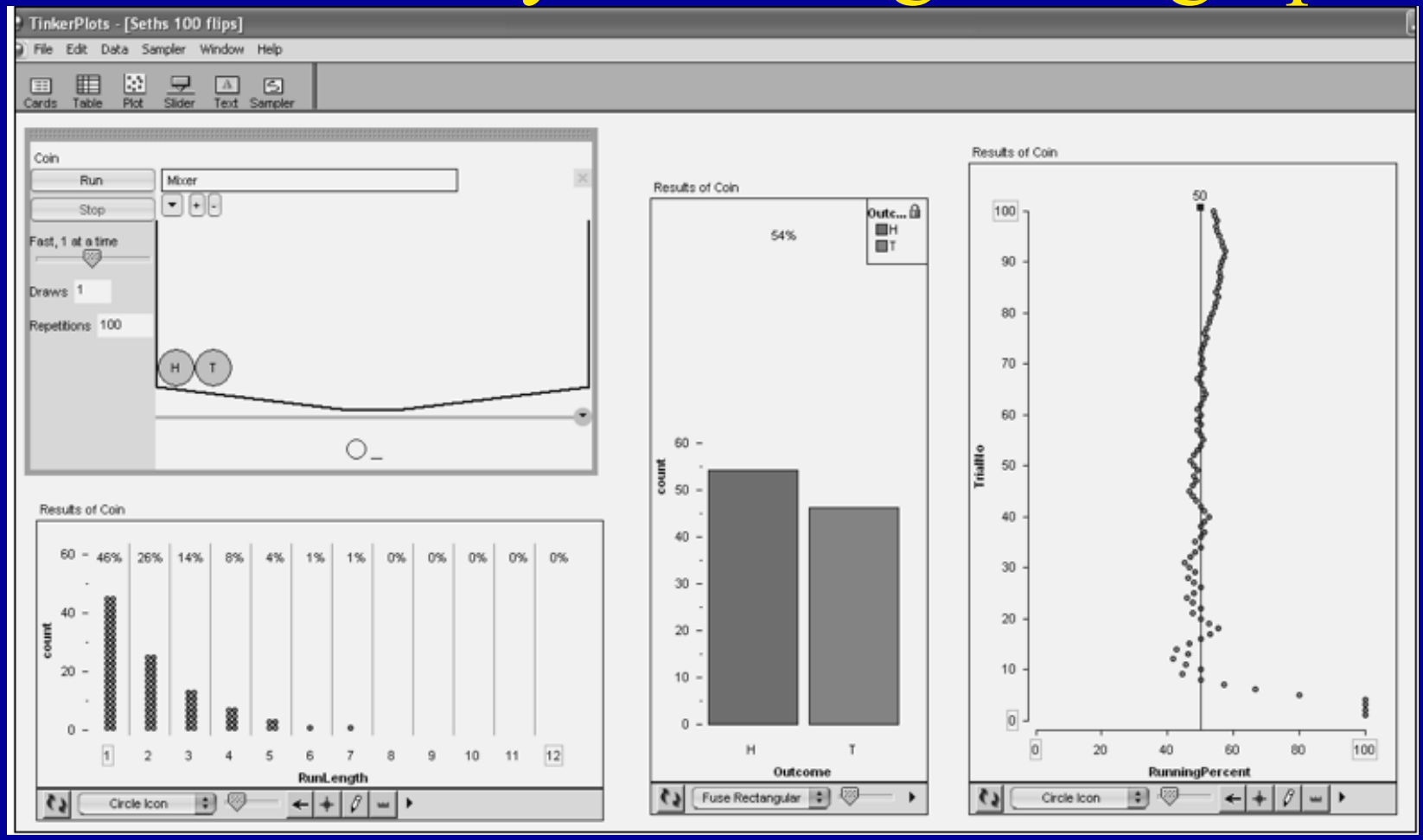
- *TinkerPlots* Sampler to consider connection with larger trials
- Trials of 100, 1000, and 10,000
- Mixer, running tally, graph of variation from expected, number of heads in a row

Tracking the simulated tossing of a coin





Screen dump of the Sampler whole class coin activity including three graphs



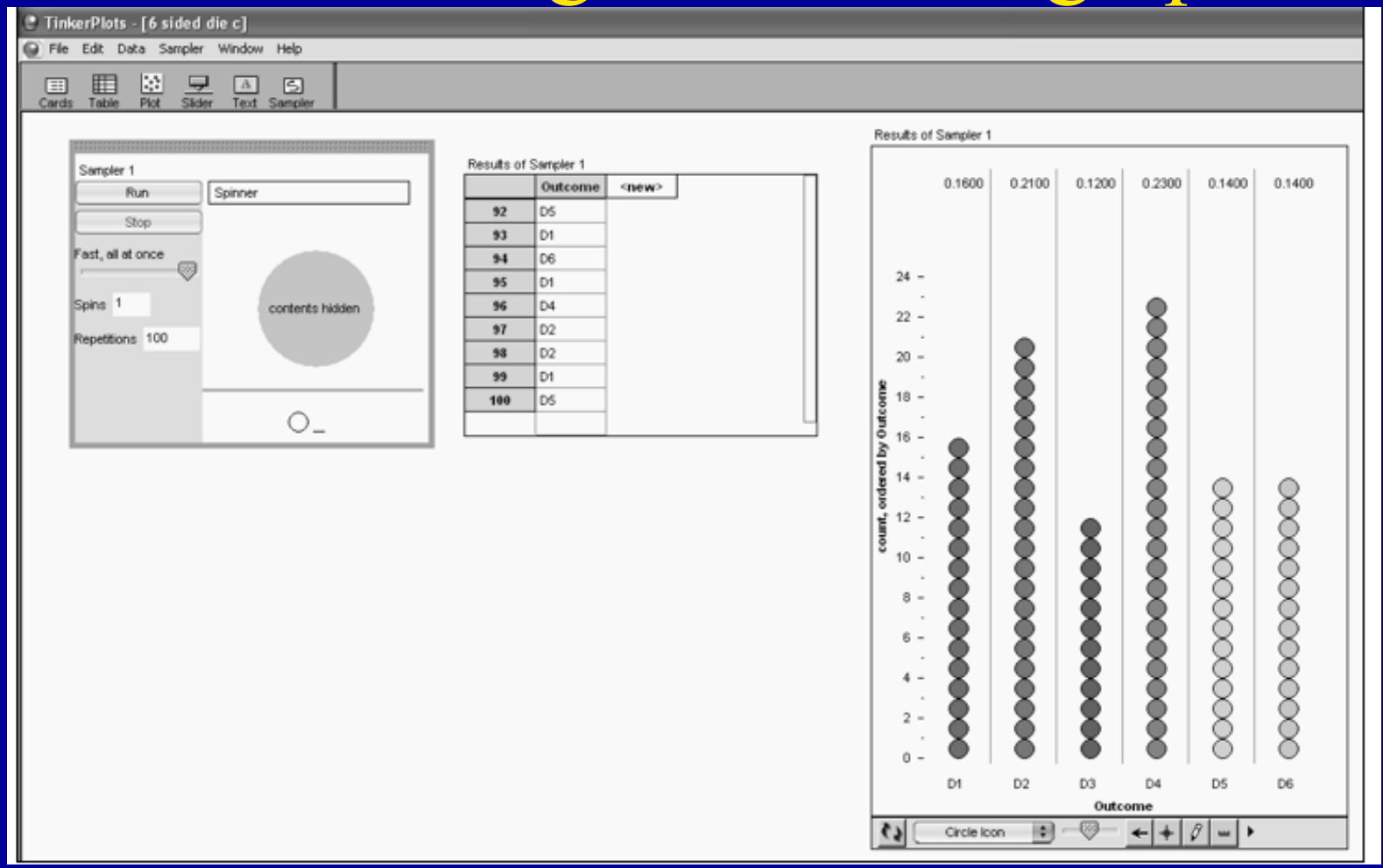
Student written reflections on …

- What is experimental probability?
- What is theoretical probability?
- How are they connected?
- Responses to these questions helped to confirm the choice of students for interview.

Student Interviews [5 In-depth]

- *TinkerPlots* Sampler for a die modeled with the spinner.
- Students asked to
  - explain
  - generalise
  - find evidence
  - apply current understanding
  - draw graphs for 10, 20, 100, 1000 die tosses
- Three dice scenarios (spinner set up hidden)
  - no loading
  - large loading
  - slight loading

Screen dump of the Sampler personal interview dice activity including a table and graph



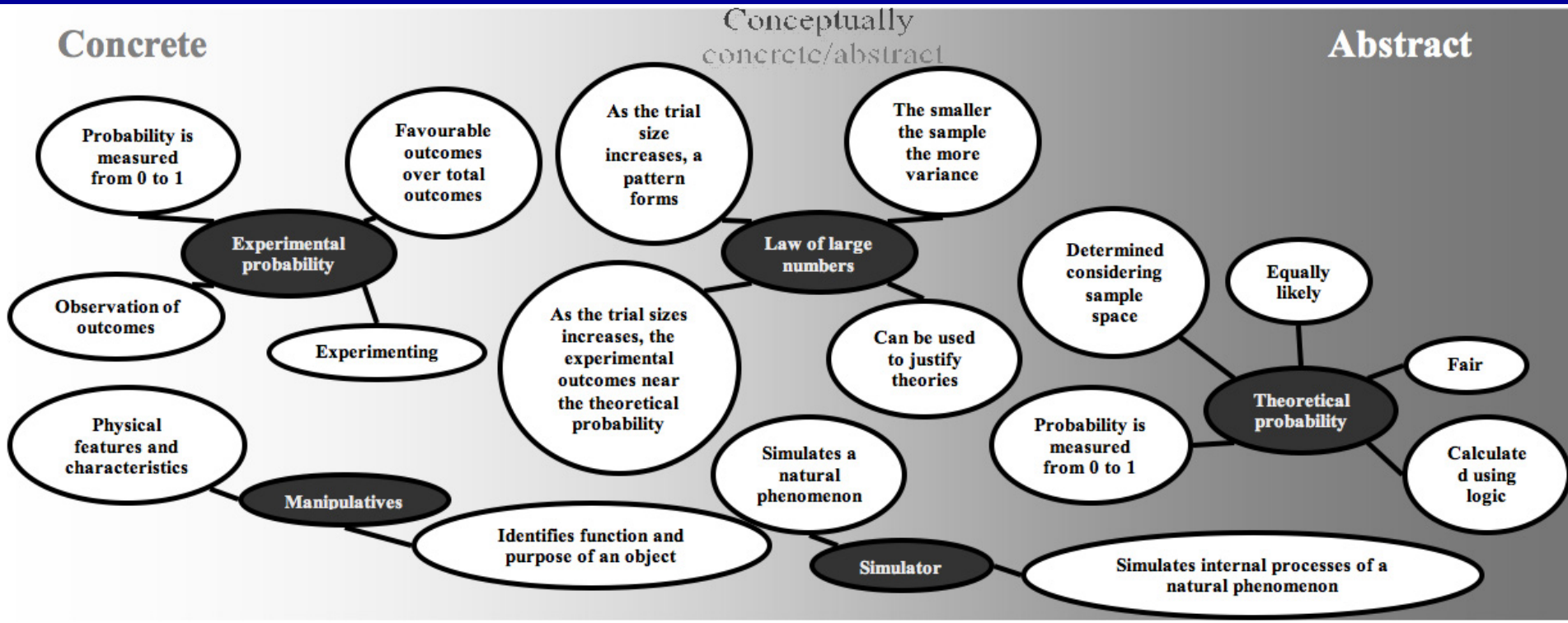
Student Interviews

- Interview ended with a discussion of the relationship between experimental and theoretical probability as experienced during the interview.
- The level of student response was based on mappings of the ideas expected to be included in the students' responses in relation to the five elements of the framework.
- The way the components of the figures were combined was assessed using the SOLO model of Biggs and Collis.

Levels of student understanding

- Unistructural responses (U): single aspects of the element and a lack of recognition of contradictions.
- Multistructural responses (M): a series of aspects of the element with contradictions likely to be recognized but unresolved.
- Relational responses (R): a linking together of aspects of the element, resolving to a large extent conflict that arose.

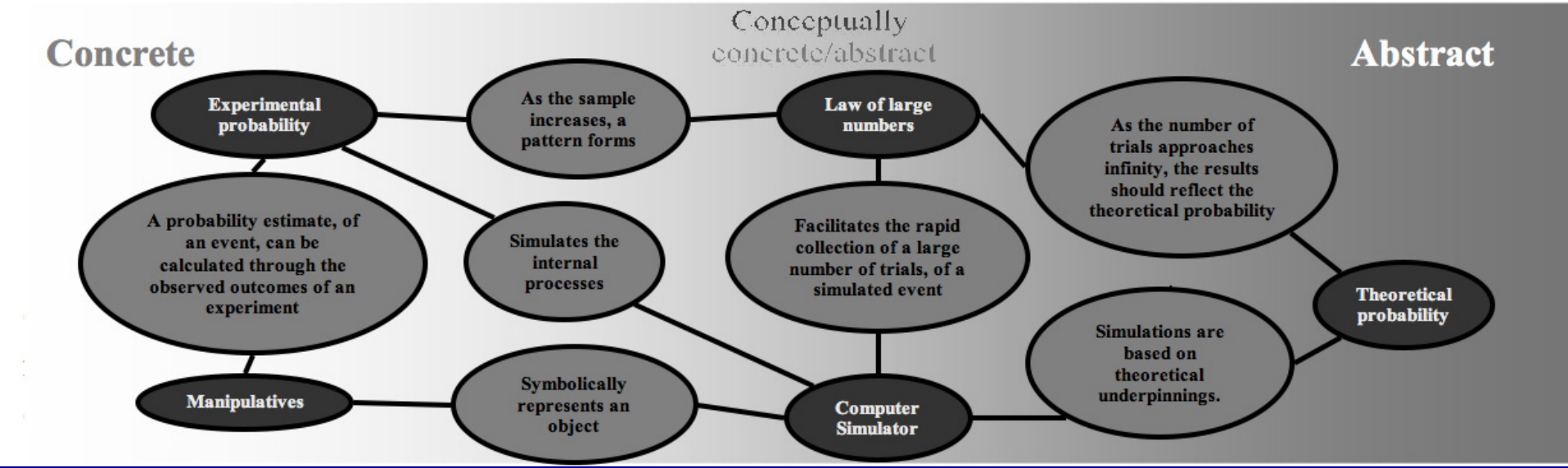
Mapping in relation to each of the five elements in Concrete to Abstract Framework



SOLO Levels for the Five Elements for Five Interviewed Students

	Manipulatives	Simulator	Experimental prob.	Theoretical prob.	Law of large No.
S1	R	R	M	M	R
S2	R	R	R	M	U
S3	R	R	R	R	R
S4	R	R	R	M	U
S5	R	R	M	M	U

Connections among five elements in Concrete to Abstract Framework



SOLO Levels for the connections made among the 5 elements

Student	S1	S2	S3	S4	S5
Level	R	U	R	M	U

Summaries of students' observed understanding

- S1: discussed smoothing out of results; larger trials determined fairness (R)
- S3: as for S1, plus used decimals to track experimental proportions approaching theoretical probability (R)

Summaries of students' observed understanding

- S2/S5: discussed levelling out for large trials but short term variation in experimental outcomes shows fairness (U)
- S4: suggested probability (in graphs) based on decimal (.167) for all sample sizes; surprised by variation in small sample simulations (M^- could not resolve conflict)

Discussion and Further questions

- Importance of proportional reasoning.
- Link of fairness and equally likely outcomes.
- Scaling of graphs plays a large roll in conceiving the leveling out of data with large samples.
- *TinkerPlots* Sampler a meaningful link – is it truly random?
- Need explicitly to map the connections for students.