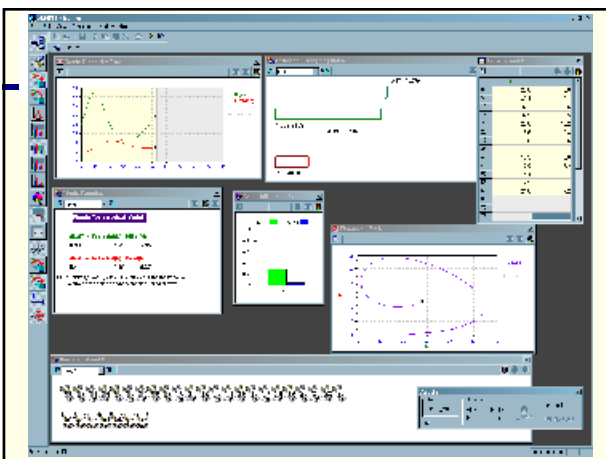


A Microgenetic Approach to Understanding the Processes of Translating Between Representations

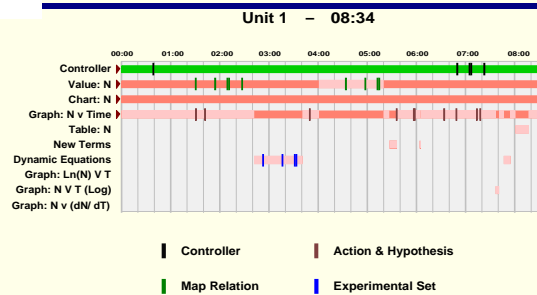
Nicolas Van Labeke & Shaaron Ainsworth
 School of Psychology &
 Learning Sciences Research Institute
 University of Nottingham

Introduction

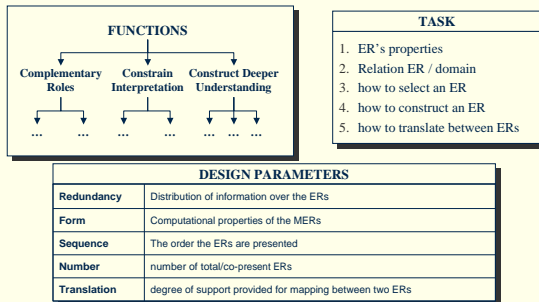
- ⚡ Previously...Van-Labeke & Ainsworth (2002) found that people learnt in 90 mins with a multi-representational simulation, but that understanding of relation between ERs hardest
- ⚡ No relation between any measure of system use and any measure of performance
- ⚡ Unanswered Questions
 - What makes learning in this domain hard?
 - Is learners' behaviour in this a short amount of time representative of their longer term behaviour?
 - Is learners relative lack of learning about the relation between ERs because of its difficulty or because they don't try to do it?



DEMIST analyser screenshot



DeFT : Design, Functions, Tasks



Study

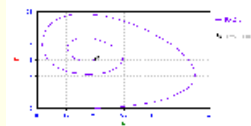
- # 3 participants
 - PJ – male, background in Computer Science
 - LN – female, undergraduate Biology
 - TW – male, postgraduate Biology, experience in modelling
- # Training session on DEMIST interface
 - (30 minutes – harmonic oscillation)
- # Learning sessions
 - Unlimited growth, Limited growth, Predation Prey, Competition
 - Each model contains four learning units and each unit had 16 ERs and may allow prediction, actions on model, parameter changes. A worksheet guide suggested some questions to explore
 - Session videotaped, an experimenter interacted with the participants.

Why learning is hard!

Inappropriate Inferences

- E.g. misreading representations (e.g. claiming two graphs peak at the same time)
- E.g. misunderstanding effects of parameters changing (e.g. changing b from 0.4 to 0.8 then d from 0.2 to 0.4 and concluding that b is more important than d rather than reasoning about $b-d$)

Prey & Predator Phaseplot



Appropriate inferences doesn't mean implications

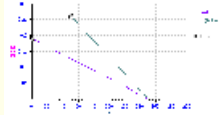
- E.g. no idea about what values of N and P represent stability points

Why learning is hard

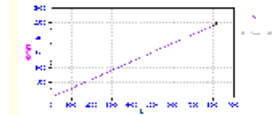
Learners have problems distinguishing useful features of ERs

- because of misconceptions: e.g. assuming that that movement across the X axis will be constant
- because of automatic scaling

Per Capita Growth rate v N



dN/dT v N



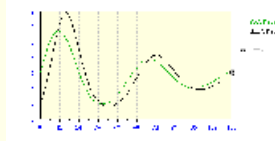
How learners use multi-representational software

- ✦ Representations which learners interact with are not necessarily the ones they are reasoning with, particularly in dyna-linked cases.
 - E.g. exploring how different parameters influence future values, enters predictions of future values in tables, looks at N v T graph and then changes value in table.
 - The table is acting as an interface to the graph.
- ✦ Each participant had a different strategy for understanding ERs and translating between ERs

Learning and ER Strategies: PJ

Interpreting an unfamiliar ER

Potential N Killed N v Time

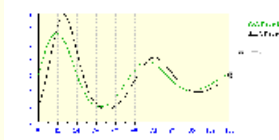


“First there is more Potential N on this side and then kill N goes down.... And then the green one goes above it and then the black ones goes above it”

Learning and ER Strategies: PJ

Using a familiar ER to interpret an unfamiliar ER

Potential N Killed N v Time



N P v Time

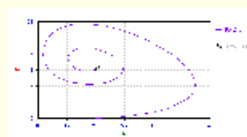


- ✦ How does this graph that relate to the P v N over time graph
- ✦ They are both the same shape, the maximum points correspond on the X scale

Learning and ER Strategies: PJ

Using a familiar ER to interpret an unfamiliar ER

Prey & Predator Phaseplot



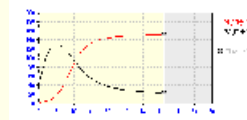
- ✦ “That’s it going up and when it goes back on itself, that is it going down”
- ✦ **What is?**
- ✦ “The population density of the prey”
- ✦ Dyna-links to time-series – “its both”
- ✦ “If it is going this way (drags mouse right) that’s N getting bigger if it goes up then that’s P getting bigger

Learning and ER Strategies: PJ

- ⚡ Goal: to learn population biology
- ⚡ Hardest task "looking at the ER and working out what that actually means"
- ⚡ Description of translation strategy
 - "Look at axes and scales, see if the numbers match and whether the pattern on the graph matches"
- ⚡ Saying what he sees, but not saying what he is seeing means
- ⚡ However as time progresses, reasoning sounds increasing like TW....

Learning and ER Strategies: LN

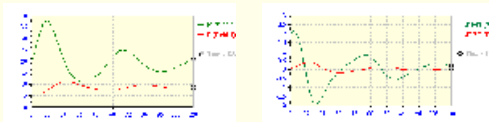
Red & Black Ant Density v T



"When the red ants are the stronger ones they reach stability and black ants can grow at the beginning until the number of red ants increase"

Learning and ER Strategies: LN

Interpreting an unfamiliar ER N, P, v, T $dN/dt, dP/dT, v, T$



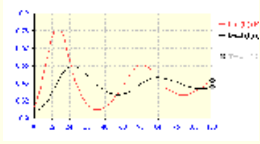
"When the change in the number of predators peaks then that's when number of prey numbers are at their highest, no just before"

Learning and ER Strategies: LN

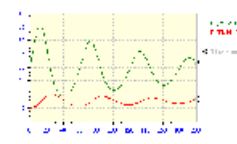
- ⚡ Goal: to learn maths and representations to begin with and biology towards the end
- ⚡ Wants to understand domain and almost sees ERs as a barrier to this. A 'representational resistor'
- ⚡ For her, the hardest task is relating ERs, she actively dislikes relating ERs and rarely uses dyna-linking
- ⚡ Translation strategy understanding each representation in terms of population biology
- ⚡ Aims to learn to select the 'right' ER for the task

Learning and ER Strategies: TW

Potential P Dead P v Time



N P v Time



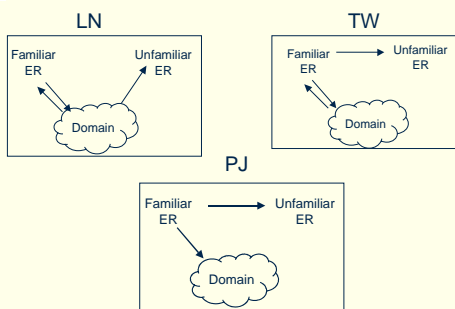
"This is the number of predators, oh it's the number killed. It has the more the same shape as the green one rather than the red one"

"While this is going up I think there are more lynx living than dying. At the point where it crosses potential = dead, and at each of those dP/dt is zero, and so that must be the maxima..."

Learning and ER Strategies: TW

- ⚡ Goal: "to learning the relationships between the ERs because its another dimension to what is going on"
- ⚡ Hardest task "relating values in equations to graphs and any sort of visual representation"
- ⚡ Description of translation strategy
 - "To find time or another dimension that was common to all of the ERsbut then ignore irrelevant dimensions. Find what is changing in both, like gradient or shape of curve"
- ⚡ Resists dyna-linking as cheating
- ⚡ More varied, when reasoning about new models or unfamiliar terms could sound very like PJ

Translation Strategies Summary



Conclusions

- ⚡ Need more time for experiments
- ⚡ The role of the teacher was crucial to what was learnt
- ⚡ The time series graphs was judged by all to be most useful followed by phaseplots (which were most consistently misinterpreted) and tables.
- ⚡ Animation style (time-singular ERs) judged to be unhelpful
- ⚡ Different translation strategies related to learners' goals
 - Which is most effective?
 - How can they be supported
 - Is dyna-linking always appropriate

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