Making mechanisms: how academic language mediates the formation of dynamic concepts

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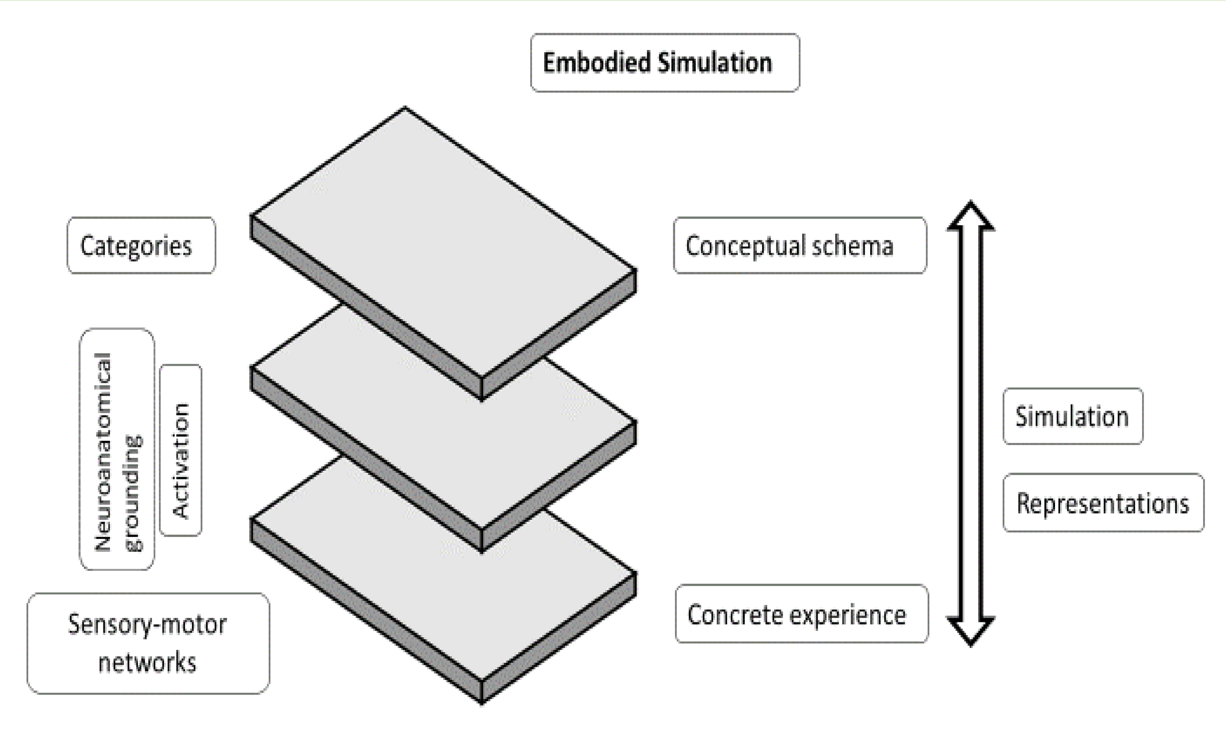
Introduction

Science learning requires students to understand, and internalise, a new way of characterising reality. This process is mediated by academic language (AL), which has features that help promote scientific thinking. The structure of AL makes it very different from the language students use in day to day life (everyday language, EL). As AL embeds a new worldview, most students find the shift from EL to AL challenging. This transition is particularly difficult for students in non-English speaking countries, as they need to learn both English and AL in parallel. Many students in such countries are first generation learners, who find this transition very difficult..

Mechanisms form a significant portion of the school science textbook. For the student to develop an understanding of these mechanisms, she needs to first comprehend the individual concepts that form the mechanism (such as stomata, guard cells), and then the mechanism-specific structural and functional configurations they generate (such as turgidity, transpiration). Thus, comprehending the mechanism requires conceptual integration.

Embodied Simulation



Embodied Simulation Model of Language

- The embodied simulation model of language is a theoretical framework under development, where language is considered to embed sensorimotor elements.
- Neuroanatomical evidence grounds this activation in the sensorimotor neural circuits
- Recent studies show that language can both trigger movements and incorporate movements

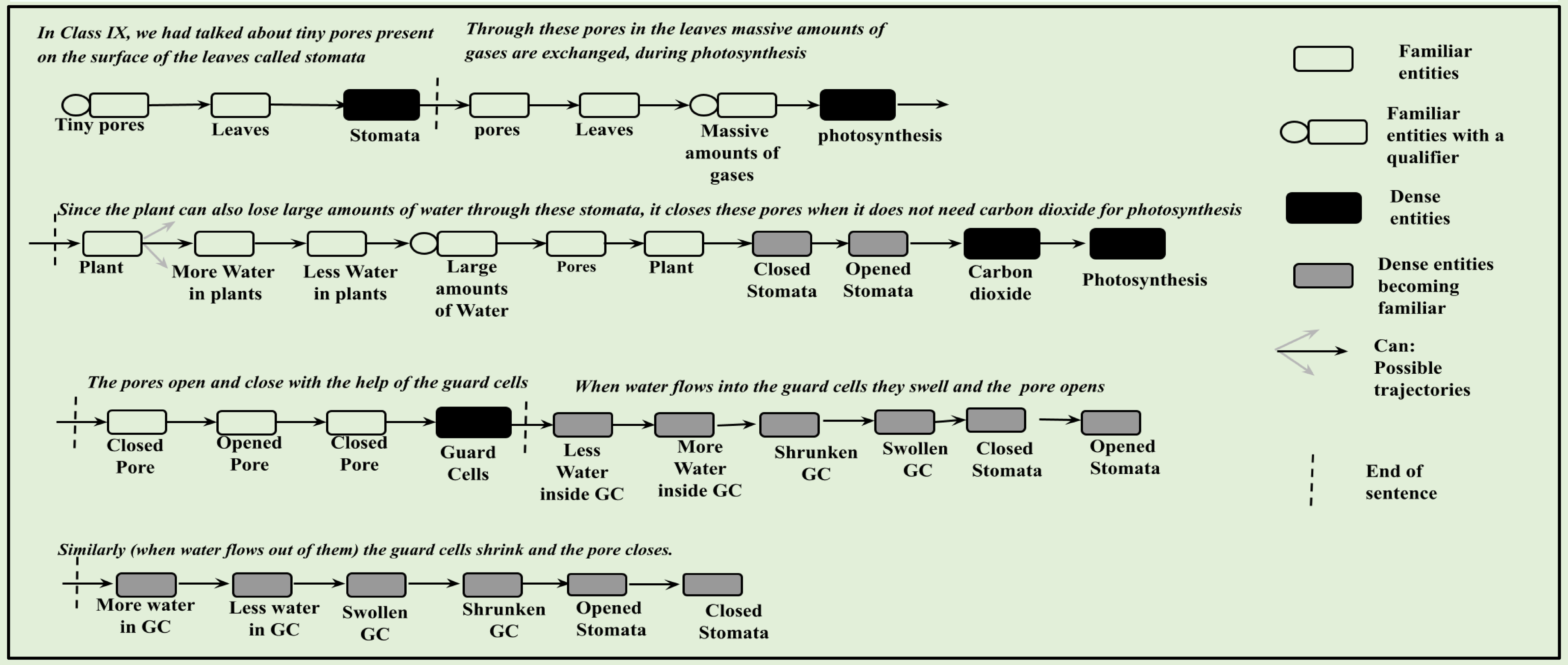
Questions:

1) How do teacher explanations help a naive student develop new conceptual structures, such as the complex mechanism of photosynthesis, which embeds other complex concepts such as oxygen, carbon dioxide, stomata, guard cells etc.?

2) Are there any patterns embedded in a teacher's scaffolding of student simulations.

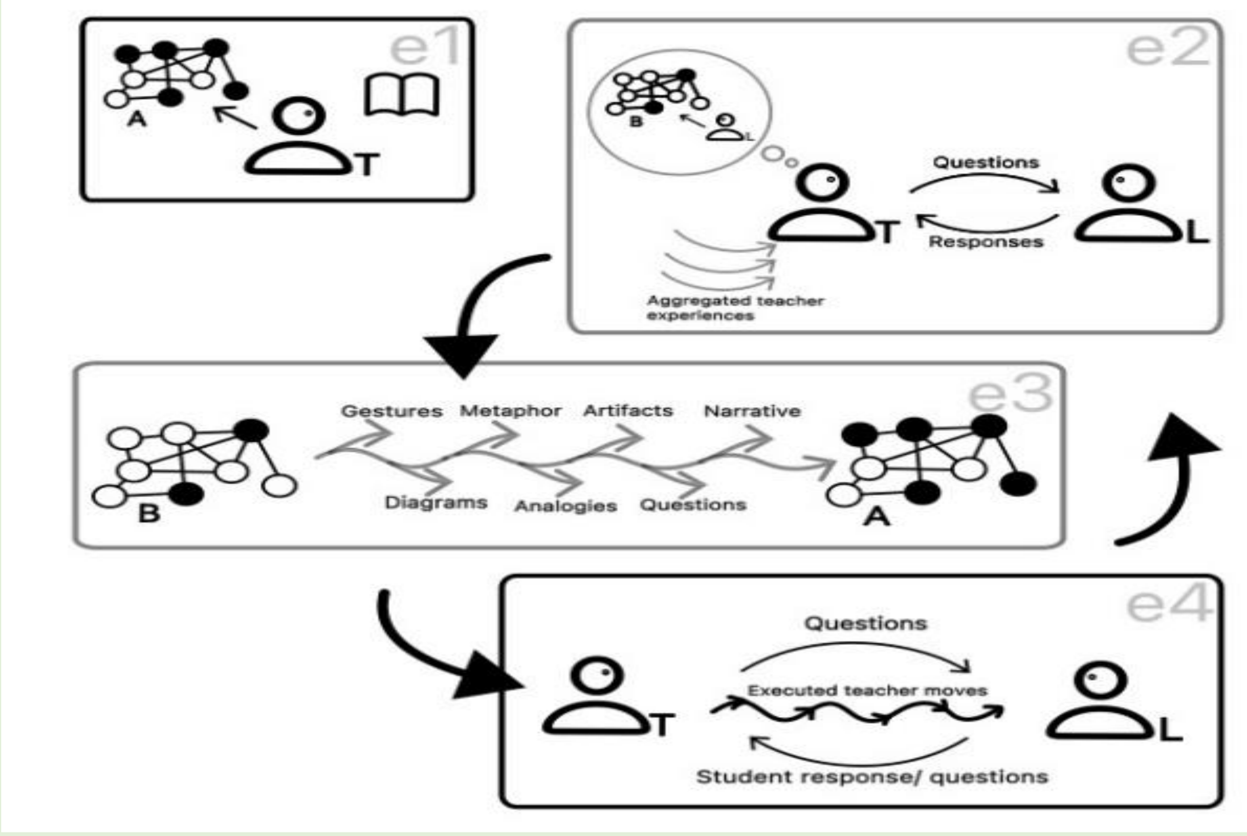
Analysis

Structural Analysis



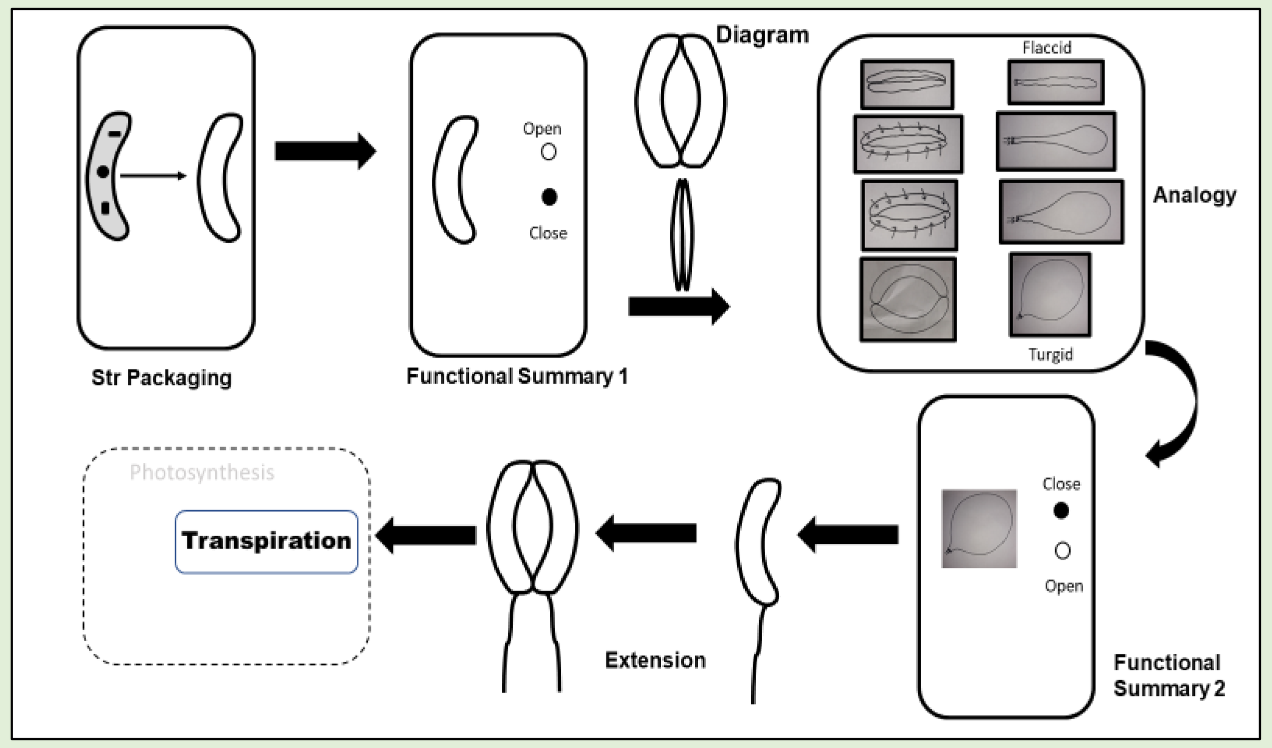
Teacher Explanation

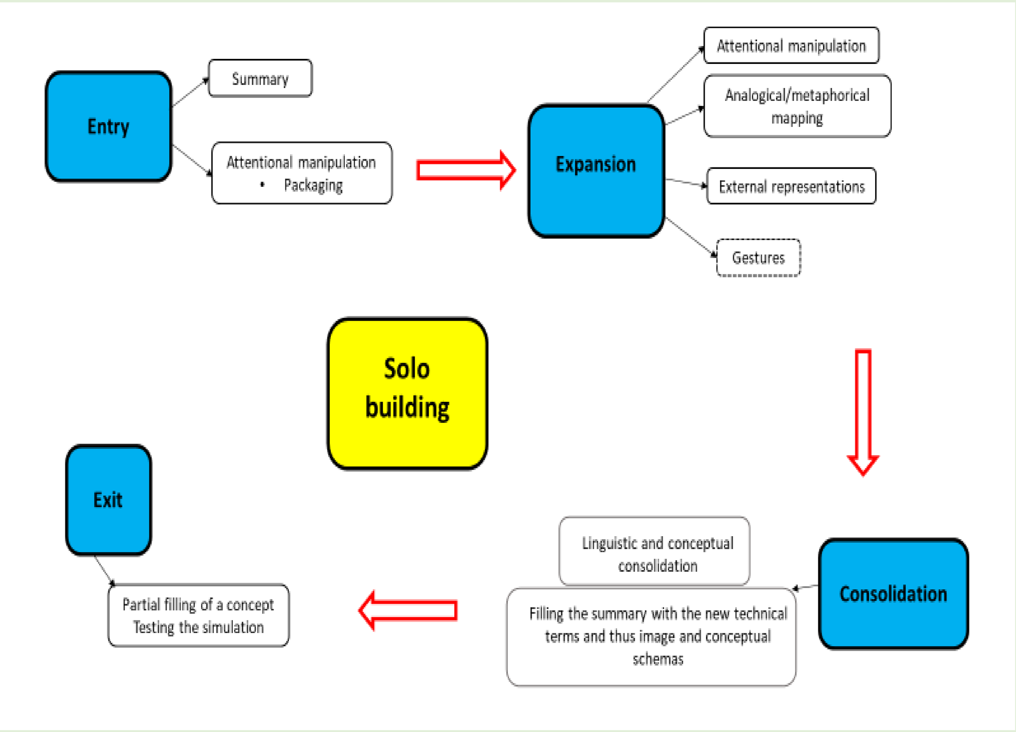
The teacher plays a critical role in the embedding of the world into technical terms, as her enaction starts the process of students learning AL and its associated simulations. Her explanatory framework is carefully built, using such enactive moves as drawings, gestures, metaphors, use of teaching props etc. The teaching narrative often consists of metaphorical or analogical mappings, where the teacher juxtaposes students' experiences (like blowing up a balloon) in relation to the mechanism, to seed the simulation of the mechanism.



Excerpt

"Turgid is nothing but it will become tight say you have a balloon I am blowing the balloon if I blow the balloon half will it b turgid no…... I really blow into it so that it becomes tight and when it is tight in Biology in a Cell I call it…... it is turgid and remember last year we studied vacuole helps in the turgidity of the cell last year we learnt this word….. so when water enters the guard cells at that time what will happen the guard cells will swell and they will become turgid and when they become turgid they pull and open the stomatal Pore."





Discussion

The teacher attempts to unpack the term in ways that would facilitate easier simulation for the learners. For this, she may choose to modulate the learners' attention, by restructuring the language in a way that would render the embedded action more available.

She may use enaction components like gestures, environmental artifacts or drawings to supplement this restructuring.

This analysis shows how the classroom could be studied as an enaction space, where multiple learners bring their respective experiential repositories and use them to develop individualized simulations, in response to AL elements. The teacher utilizes these, as well as her own judgements, to develop enaction's and external representations that converge individual-level simulations.

Further, most embodied learning technologies do not focus on supporting teachers. Technological systems that allow teachers to generate more evocative simulations in students, integrating technical terms smoothly with the mental simulation, would be very helpful in addressing the AL problem, particularly in non-English speaking countries.

Our analysis indicates that these two threads (supporting AL learning, supporting teachers) are best addressed together. However, this requires moving learning environment design into new discussions, related to narratives and their role in generating mental simulation of dynamics.

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Acknowledgements

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