

Putting STOCHASMOS to conceptual change ends

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The learning environment and its conceptual change goal

This learning environment is addressed to primary-school students of the 5-6th grade (10-12 years old). Students have to design a solution to the problem of eliminating radiation fog in a limited area and for a short time period so that medical helicopters can land. The space and time constraints are determined by the realities of helicopter landing. It is an open-ended problem and students have to produce as many well defended design proposals as possible.

By the end of the intervention students are expected to: a) demonstrate an understanding of the structure of fog, the relative size of molecules, water droplets and other selected small entities, evaporation and condensation b) demonstrate snapshots of the way their design will work having microscopic quantities (molecules and water droplets) as heroes c) being able to use a model of water droplet taking account of both incoming and outgoing molecules in order to argue about the efficiency of their solution.



The challenge for our design

STOCHASMOS *Inquiry Environment* fits more easily to a scheme that includes: A Mission and Various categories of Data organized in hierarchical trees

The multimedia architecture allows for a free roaming from the side of the students. The freedom can be structured a) explicitly through directions given in the text of the *Inquiry Environment* b) through directions given or demands posed in the templates of the *Workspace* c) through some kind of training outside of the software (e.g. a suggested inquiry cycle) or d) implicitly (through expectations that students themselves form)

In our case we faced a series of challenges:

- Students' lack of skills related to decoding physics texts
- Students' lack of experience with producing multistep mechanistic explanations
- Since conceptual change is needed, information may be misinterpreted by the students if left on their own devices
- Conceptual understanding needs time to be built and demands prior engagement with relevant concepts. This goes against the sense of autonomy of students

Meeting the challenge

In order to meet the first and second challenge there were designed offline activities where the teacher had the initiative guiding students in:

- Connecting texts with images
- Constructing multistep mechanistic explanations
- Dramatizing the "droplet plus molecules" mode

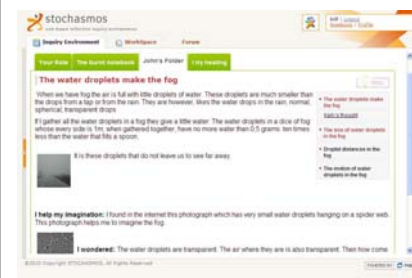
Moreover the teacher often intervened by demanding groups of students to publicly defend their designs.

In order to meet the third challenge we included in the Inquiry Environment information that contradicted the interpretations that students would hastily make based on some part of the information presented. In the offline mode we also suggested to the teachers to ask questions that had as a goal to problematize the expected initial design proposals of the students.

In order to meet the fourth challenge (but also as an assistance to the previous challenges as well) the whole Inquiry Environment was structured along a story. When reading the mission the students find themselves in the crisis point of an evolving story which they have to move on: A hero needs their help to complete a socially beneficial assignment. Data or information are already gathered by the hero and they are structured in ways that can work as models for the students.



Modeling 1: The hero reports one of his ideas in his notebook



Modeling 2: The information presented as structured by the hero

Moreover the hero reports interactions with a "helper" (physicist) and has to report finally to an "assessor". This structure gives a lot of potential to build on the motivational landscape of the learning environment (by "playing with the characteristics of the hero and the helper) and also gives the opportunity to the teacher to be a real coach, since the "assessor" is now somebody else. We intensified the presence of the assessor by creating templates that were addressed directly to the assessor and by taking advantage of the opportunities for electronic feedback to the students' templates.

Finally the story allowed us the option of double reading:

- There was a surface, easy to understand, sequence of the information presented: The hero's notebook, the hero's folders, reports on discussions with the helper on a particular solution that he worked more.
- But there was also a second interpretation of the same structure

1 st Interpretation	2 nd Interpretation
Hero's notebook	Strategy for analysing solutions
Hero's folder	Structure of fog, motion of droplets
Hero's worked out idea	The model of droplet with incoming and outgoing molecules and its interpretations

As a result of these moves on our side

- The implementation demanded quite a lot of time
- The teacher had to intervene at specific points and impose through his authority that the students had to "pass from a training session" in order to be able to continue. Though students might feel a kind of impasse it was not obvious to them why this particular kind of training was what they needed
- The implementation demanded high quality interventions by the teacher. The teacher needed to have both good understanding of the subject matter and understanding of students' ways of thinking in order to intervene in a productive way

Discussion along the Four Main Issues

•Costs and benefits of the inclusion or exclusion of process-flow support in a specialized authoring tool

We did this in an implicit way with respect to the sequence of dealing with concepts, through the natural flow of the story. It worked to some extent since the implementation ended up being quite sensitive to the teacher's ability to help students make the transition between the two readings of the story. On the other hand the presence of this double reading helps the teacher gain time and creates a point for tinkering that can help organize his teaching

•Costs and benefits of the complementary design of offline activities to augment the computer-based learning environment.

In our case that was inevitable. It also made the intervention last longer. However in our case off-line activities were introduced as ways to enrich narratives (to combine text and image when decoding physics texts, to understand the new heroes: droplet and molecules, to understand the sequencing of events in mechanistic explanations). Since the story itself was a narrative we think that this helped creating a structural synergy.

Main Point1: Based on the importance of building a rich story for our design we propose that an authoring tool should be checked for or perhaps improved by considering its capacity for implementing rich narratives.

•The contribution of specialized authoring tools for prompting and guiding pedagogically-focused design discussions.
•The importance of exposure to past implementations to the efficacious use of specialized learning environments.

Based on our experience, Computer supported collaborative learning environments are at the same time instruments of professional development for teachers. It is impossible for a new teacher to implement the full potential of a good learning environment. One can imagine successive implementations in successive years where the teacher gradually develops professionally and the implemented environment arrives to its full capacity.

In our implementation the features of the learning environment, students contributions in the templates and participation in classroom discussions and the directions of the teacher guide provided a rich environment for teacher improvement. Teacher participation in local alterations to the learning environment is an option that we did not try (although provided by STOCHASMOS).

Main Point2: An authoring tool should be checked for or perhaps improved by considering its capacity to support a medium range (of the order of 3-4 years) professional development of the teachers.

A synergy of professional training along inquiry environments can possibly create a sophisticated audience for the inquiry learning environments designers and thus create the conditions for bringing authoring tools to mature forms in a way similar to the way that musical instruments arrive to mature forms through the existence of sophisticated audiences different from the communities of music composers or music instrument makers.