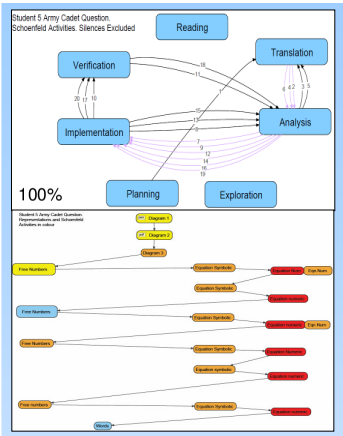
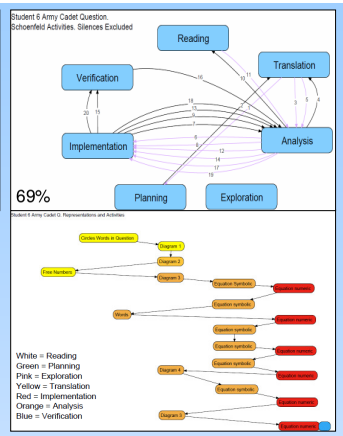
Observing the problem solving strategies of students

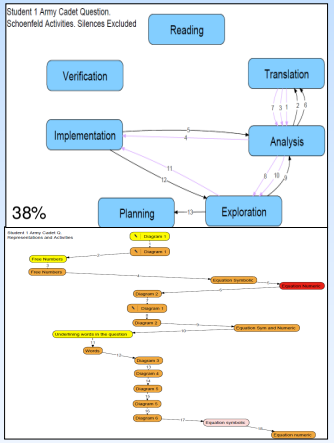
Marsali B. Wallace, Ross K. Galloway

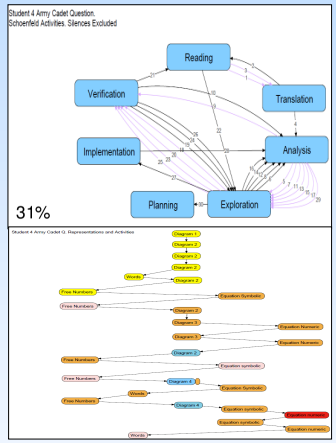
EdPER Edinburgh Physics Education Research

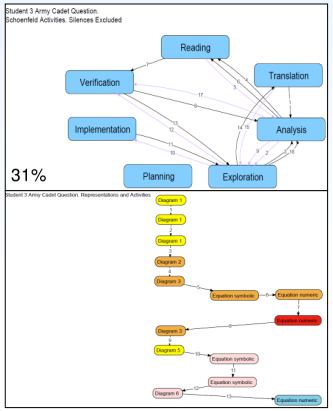
The University of Edinburgh

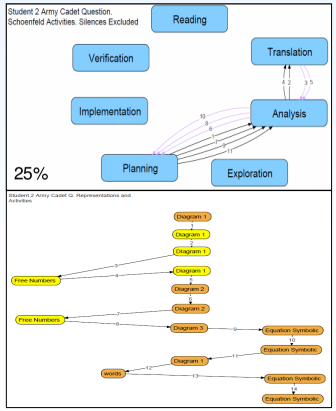












Problem solving: What do our students do?

We have employed the Think Aloud technique [1] with Livescribe smart pens to investigate first year undergraduate student problem solving. One of the aims of the study was to determine what transitions students make between activities while solving problems to give an indication of their executive decision making at a tactical and strategic level [2].

During the second semester of our first year physics course, students from each of the performance quartiles from the previous semester were invited to attend a problem solving session. In total, 6 students participated (but none did so from the lowest quartile). Each student was asked to solve two mechanics problems under Think Aloud conditions.

Student activities were coded according to two models: a behavioral activity scheme devised by Schoenfeld [2] and adapted by Kohl and Finkelstein [3]; and our own set of problem representation codings.

Results and Discussion

Student activities and use of representations are illustrated for both questions. The blue networks show transitions between the behavioral activities, and the multi-colored networks show use of multiple representations. Colors in the latter figures indicate the student's behavioral activity during the use of that representation. Detailed analysis of individual networks is not our focus here: as a preliminary investigation we seek to identify overall structure and patterns which may indicate problem solving archetypes.

The students are ordered according to task success (highest at the top). The top panels in each of the four columns represent successful attempts at the problems. Interestingly, the patterns of activity show similarities between the successful students in each of the distinct problems (question 1 in the left two columns, question 2 in the right two columns).

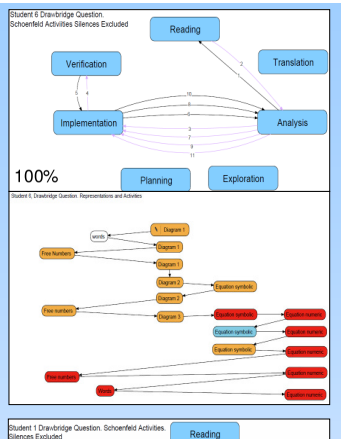
Although many students had links between Analysis and Implementation, these connections were particularly pronounced in the successful students. None of the students made extensive use of Planning and Verification. These are arguably control type activities and perhaps do not necessarily occur, or if they do, they are not explicitly vocalized (because the students are not actively aware of them).

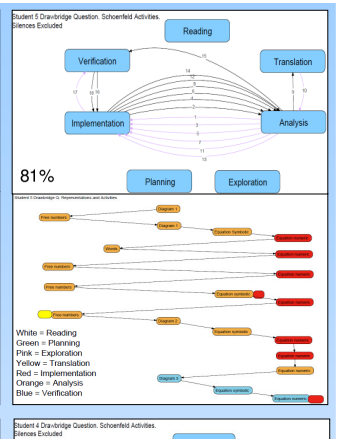
Attempts by less successful students show either very simple networks, where the student seemed unable find any effective approach, or very complicated patterns, where they repeatedly changed approach but were unable to progress the solution. These students generally lacked the distinctive sequential alternations between use of symbolic and numeric representations which appear characteristic of the more successful students.

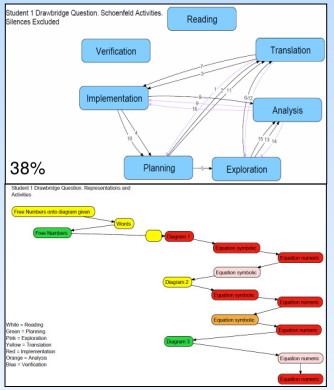
Future Research Questions

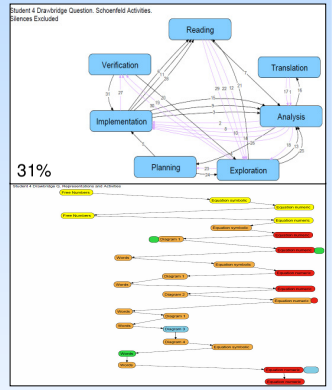
- What do experts do in real problem situations (not exercises)? Will their patterns resemble those of the successful students or will they differ?

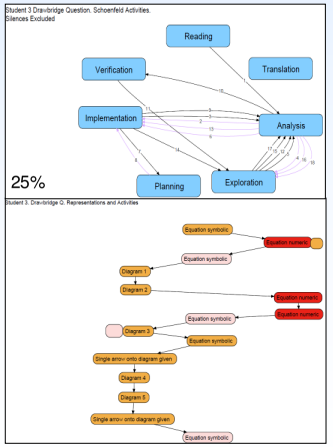
- Why do we and others [3] observe little planning and verification? According to cognitive models, these activities should be expected to be going on constantly in the background [2] – perhaps these activities could be combined into one category called 'monitoring' (divided into tactical and strategic levels) which could cover metalevel control of the solution. Students are unlikely to tap into appropriate and effective resources and heuristics if they do not have control, or ongoing monitoring, of their problem solving process [2]: problem solving strategic tools will only be really useful if students know when and where to use them.

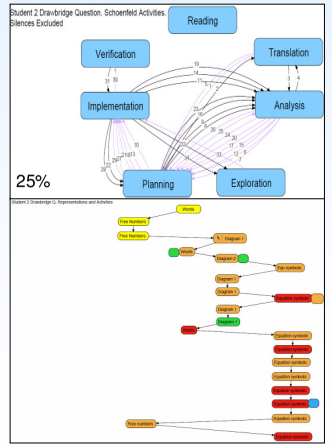












References

[1] Ericsson, K.A. and Simon, H.A. (1984) *Protocol Analysis*, MIT Press

[2] Schoenfeld, A. (1985) *Mathematical Problem Solving*, Academic Press

[3] Kohl, P.B. and Finkelstein, N.D. (2008) "Patterns of multiple representation use by experts and novices during physics problem solving", Physical Review Special Topics – Physics Education Research **4(1)** 010111

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