Brainstorm 11/21/2003: Deductive Tutors

Task \(\rightarrow\) results
Results + prior results \(\rightarrow\) knowledge
Knowledge + prior knowledge \(\rightarrow\) new knowledge

See more formal definition on other sheet.

The idea here is that at some point the student will have performed enough tasks yielding enough results such that the “goal” piece of knowledge is finally assimilated. Along this process of experimentation and deduction, many things can interfere with the shortest and optimum path to assimilate the “goal” piece of knowledge. These may include: (Brainstorm these)
- Recollection of Experimental Results
- Missing concepts that allow for a proper deduction
- Inability to combine newly attained knowledge with previous knowledge
- Recollection of previously attained knowledge
- Misunderstanding experimental premise
- Inability to interpret results properly
- Inability to assimilate information through a particular modality
- Inadequate understanding of scientific/deductive process
- Misunderstanding the use of a particular tool/instrument in gathering results
- Inadequate common knowledge

This list may go on and on.

The tutor should choose remediations and remediation strategies based on identified interfering processes to the students learning. The problem now then includes identification/diagnosis of the interfering processes.

Can this be done?
Before this even, to lay out a deductive path or set of paths. One must have very clear “tasks” which result in very clear “results” which result in very clear deducible knowledge pieces.

Is that possible?
- The easier part is defining the tasks, these would include not only experiments, but also other things like looking up of information, studying an animation.
- A similarly easier part is defining the results of these tasks. One needs to be careful not to confuse “results” and “knowledge”. They can be distinguished in that “results” have not been processed by the student in any manner. Whereas “knowledge” assumes that some processing of the world information, even if that is only the action of taking an external piece of information and reading it or storing it in one’s memory etc.
- The most difficult of these preliminary tasks for an isolated task \(\rightarrow\) result \(\rightarrow\) knowledge processing sequence is defining the knowledge that is to
be interpreted from a result. Here we need to understand that the result must be combined with some prior “knowledge set” in order to be transformed to a piece of knowledge. At the simplest we could say that a student looks up a word, then a definition is presented, and the resulting knowledge gained in that task is “understanding the meaning of that word”. We are only concerned with defining knowledge that can come directly from the result for now.

In this simple case, many assumptions are being made, some of which will be relevant in different contexts. We must make assumptions however to simplify things or this becomes impractical. e.g. student can see the result, student can read the result, student understands all the words in the result, student understands the task taken to achieve the result, etc.

Given that we may make certain assumptions, reasonably in a particular context, we may then define a relevant knowledge set obtained from a task→result operation in isolation.

Note that defining the task and results are much easier and can be more precisely defined on the designers part. The knowledge ideally attained on the other hand can be difficult to define properly by the designer. This definition will need to be concrete, and distinct, so that it can be used properly later on. If not in words, at least it must be satisfactorily concrete in the designer’s mind.

Let’s take a closer look at task→result→knowledge sequence with regard to where interference might arise.

Task –
- Student needs to have certain skills and abilities to perform the task. If it is pushing a button, then you need that ability. If it is navigating the VRML, then you need that skill set.

Task→Result -
- The assumption is that the “result” occurs immediately following the completion of the task. Problems here can only come from outside the student. Software glitch, etc.

Result –
- The result

Result→Knowledge –
- Many things can interfere with this process, these can be due to the student’s state or the state of the result.
- E.g. if the result is a text window, it may be hidden under some other windows because of another application, but it effectively blocks the student from processing the result. If the result is an animation, the animation may play too quickly, or only once, etc etc
- On the side of the students, many things have been touched on already.
For a tutor, it would be difficult to keep track of and diagnose problems with in this task→result→knowledge process if every interfering item was taken into consideration. So ideally, one must design a tutor to be able to diagnose a subset of these interfering processes.

At the next level, we begin looking at the deductive reasoning process. We add an additional step to the task→result→knowledge process and so it looks as follows:

Task + basic skillset → result
Result + common knowledge → direct knowledge
Direct knowledge + prior knowledge → deduced knowledge

Here the direct knowledge attained from a result is then further combined with all prior knowledge. This may or may not result in any deduced knowledge. It is up to the designer to define by making some assumptions what is and what is not deduceable from a knowledge set.

It is most likely, even assuming ideal conditions/abilities/skills on the student’s part that all knowledge pieces that are considered mathematically deduceable will be attained. One might assign ranks/difficulty levels to attainable deduced knowledge pieces and work with that in some fashion but for now it will be a black and white world.

So, the designer must define the mapping of deduction. That is to say, direct knowledge piece “k” + prior knowledge “K” will produce knowledge pieces k2, k4, k10 etc. Again this is where defining the knowledge that can be deduced might become troublesome.