Toward supporting hypothesis formation and testing in an interpretive domain

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Abstract. The research field of AI & Education has long been interested in cognitive processes in which students formulate and test hypotheses by considering them in light of specific cases. However, few if any of the systems that have been built target domains which are ill-structured and in which determining whether a hypothesized rule and proposed outcome are consistent with past decisions is a matter of interpretation, rather than deductive inference. The goals of our project are to (1) develop an AI model of hypothesis formation and testing in an interpretive domain, US Supreme Court oral arguments and (2) to use it in an intelligent tutoring system to guide law students in learning that process. As a first step toward these goals we will conduct an experiment to evaluate whether self-explanation prompts facilitate learning by studying argument transcripts.

Introduction

The research field of AI & Education has long been interested in processes of inquiry learning in which students formulate hypotheses and test them against specific cases ([1-5]). These processes as they occur in ill-structured domains, however, have received little attention, one exception being the work on CATO [6-8]. Oral arguments before the United States Supreme Court offer prime examples of hypothesis formulation and testing in an ill-structured domain. In these arguments, advocates frame hypotheses for deciding a case and the Justices challenge them, often by posing hypothetical scenarios that test the hypotheses' limits. While these processes in the legal domain bear some resemblance to the corresponding processes in science or mathematics, in the legal domain determining whether a hypothesized rule and proposed outcome are consistent with past decisions and plausible hypotheticals is much more a matter of interpretation.

The goals of our project are (1) to develop a computational model of the reasoning processes exemplified in US Supreme Court oral argument and (2) to use the model as the basis for an intelligent tutoring system that will engage students in an appropriately simplified version of these processes.

A planned experiment

As a first step, we will run an experiment to find out whether specific prompts for self-explanation help students gain a deeper understanding, as they study transcripts of Supreme Court oral arguments. The cognitive science literature supports that studying examples is an effective learning strategy at the early stages of acquiring a cognitive skill [9] and that self-explanation prompts can help students gain a deeper understanding of the subject matter ([10-12]). However, the effectiveness of prompts has not yet been shown in ill-structured domains as complex as the legal reasoning exemplified in Supreme Court oral

Table 1: Excerpt of transcript of oral argument made before the US Supreme Court in *California v. Carney,* 105 S. Ct. 2066 (1985), with self-explanation prompts added

Argument Transcript	Self-Explanation Prompts
QUESTION: Well, what if the vehicle is in one of these mobile home parks and hooked up to water and electricity but still has its wheels on?	
MR. HANOIAN: [*9] If it still has its wheels and it still has its engine, it is capable of movement and it is capable of movement very quickly.	1. Do you think H's response is effective?
QUESTION: Even though the people are living in it as a home and are paying rent for the trailer space, and so forth?	2. Why are the Justices adding these features to the hypothetical?
QUESTION: Well, there are places where people can plug into water, and electricity, and do. There are many places, for example, in the state I came from where people go and spend the winter in a mobile home. And you think there would be no expectation of privacy in such circumstances?	3. Why does it matter whether there would be expectations of privacy? 4. If it was clear that there is, or should be, a high expectation of privacy in the current fact situation, would that favor H's position? 5. Nothing is said from which we can infer how this particular hypothetical should be decided. Does that matter? That is, what good is it to use hypotheticals whose outcome is unknown? Wouldn't it be better to cite past cases, whose outcome we do know?
MR. HANOIAN: Well, I am not suggesting that there is no expectation of privacy in those circumstances, Your Honor.	6. By conceding that there are expectations of privacy in the hypothetical scenarios sketched by the judges, does H not reduce his chances of winning the case at hand? 7. Does H concede that the mobile home park hypothetical should have the opposite result as the case at hand? 8. How would H distinguish the current case from the mobile home park hypothetical?

arguments. In light of the evidence that prompts do not benefit all students equally ([10, 11]), it is important to ask how effective prompts are in such challenging domains.

Table 1 shows excerpts from oral arguments made in the case of *California v. Carney,* 105 S. Ct. 2066 (1985), with self-explanation prompts inserted. This case involved the legality under the 4th Amendment of the US Constitution of a warrantless search of a motor home located in a downtown San Diego parking lot. Police suspected defendant Carney of trading marijuana for sex acts. After they questioned a boy leaving Carney's motor home, agents entered the motor home without a warrant or Carney's consent, observed marijuana, and arrested Carney. The case pitted two conflicting principles: the State's right to deal effectively with the exigent possibility that evidence of a crime will disappear versus the citizen's constitutionally protected expectation of autonomy and privacy in his home. In the oral argument, the State's attorney, Mr. Hanoian, proposed a bright line test: if the vehicle/home is capable of self-locomotion, then no warrant is required to search it. As shown in Table 1, he then has to respond to the Justice's challenge hypothetical: what result would his test produce when applied to a summer motor home with wheels that is hooked up to utilities? Mr. Hanoian responds that such a vehicle still might be moved in a hurry, but concedes the owners would have some expectation of privacy. Some of the self-explanation prompts focus on the effectiveness of that response. Others focus on the Justices' strategies and possible reasons for posing hypotheticals.

Discussion

In order to evaluate the effect of the self-explanation prompts, the study will compare the learning results of students studying argument transcripts with and without self-explanation

prompts. A pilot study involving two law students, a first-year student and a second-year student, provided some evidence that the prompts are useful. The students went through the *Carney* transcript twice, the first time without self-explanation prompts, the second time with. Each time, they were asked to answer a number of questions about the argument exchange they had just studied. We saw a difference in the quality of the answers between the first-year and the second-year student, indicating that the material is challenging. Further, we saw that the answers of the first-year student improved, after studying the transcript with the self-explanation prompts. Of course, such evidence is preliminary, due to the "small N". Also, the improvement in the answers could be attributed simply to the fact that the student went through the transcript twice. This confound will be avoided in the actual experiment by having a control group. We are currently working on developing a suitable task by which we can measure any improvement in students' argument-making capabilities, a preliminary challenge for any research in an ill-structured domain.

We expect the study to yield information about how students understand and make arguments. This information will help us start to build an argument model and develop an intelligent tutoring system. The study will also contribute to cognitive science by testing whether specific self-explanation prompts can help students to learn to engage in a process of hypothesis formation and testing in an ill-structured domain.

Acknowledgements

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