Intelligent tutoring systems (ITSs) are computer programs that model individual learners and adapt instruction to help each learner differently. One way ITSs differ from human tutors is that few ITSs give learners a way to ask questions. When learners can ask for help, their questions have the potential to improve learning directly and also act as a new source of model data to help the ITS personalize instruction. Inquiry modeling gives ITSs the ability to answer learner questions and refine their learner models with an inexpensive new input channel.

In order to support inquiry modeling, an advanced planning construct is applied to ITS learner modeling. Partially observable Markov decision processes (POMDPs) differ from more widely used ITS architectures because they can plan complex action sequences in uncertain situations with machine learning. Tractability issues have previously precluded POMDP use in ITS models. Priority queues and observation chains modify the traditional POMDP representations to make them scale well and encompass the large problem sizes that real-world ITSs must confront.

A new ITS was created to support trainees practicing a military task in a virtual environment. The development of the Inquiry Modeling POMDP Adaptive Trainer (IMP) began with multiple formative studies on human and simulated learners that explored inquiry modeling and POMDPs in intelligent tutoring. The studies suggest the new POMDP representations will be effective in ITS domains having certain common characteristics.

Finally, a summative study evaluated IMP’s ability to train volunteers in specific practice scenarios. IMP users achieved post-training scores averaging up to 4.5 times higher than users who practiced without support and up to twice as high as trainees who used an ablated version of IMP with no inquiry modeling. IMP’s implementation and evaluation helped explore questions about how inquiry modeling and POMDP ITSs work, while empirically demonstrating their efficacy.