Intelligent Tutoring Systems for Ill-Defined Domains: Assessment and Feedback in Ill-Defined Domains

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Defining “Ill-defined problems”

**Ill-defined problems typically:**
- lack formal methods to verify solutions;
- lack widely accepted domain theories characterizing relevant concepts and relations;
- involve designing novel artifacts rather than verifying existing results;
- rely on open-textured concepts subject to debate;
- do not decompose into independent subproblems.

**3 types of ill-defined problems:**
- Open-textured problems:
  - rely on open-textured concepts for their structure and definition.
- Open-specified problems:
  - have unstated specifications or goal criteria.
- Open-structured problems:
  - lack clear substructure allowing for definition of partial solutions or subproblems.

**Solution processes in ill-defined problems cycle through:**
- Recharacterize problem to specify undefined components, identify constraints, or select among alternatives;
- Explore consequences of given characterization in the problem space;
- Justify characterization in terms of relevant concepts or principles and to deflect anticipated attacks.

From Lynch, Ashley, Pinkwart, Aleven (submitted) “Concepts, Structures, and Goals: Redefining Ill-Definedness”
# ITS Development in Ill-Defined Domains

<table>
<thead>
<tr>
<th></th>
<th>ITS 2006</th>
<th>AIED 2007</th>
<th>ITS 2008</th>
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<tbody>
<tr>
<td>Medical diagnosis</td>
<td></td>
<td>✓✓</td>
<td>✓</td>
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<tr>
<td>Legal reasoning</td>
<td>✓</td>
<td>✓✓</td>
<td>✓</td>
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<tr>
<td>Intercultural relations</td>
<td>✓</td>
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<td>✓</td>
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<tr>
<td>Ethical reasoning</td>
<td>✓</td>
<td></td>
<td>✓</td>
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<tr>
<td>Language learning: vocabulary, grammar</td>
<td>✓✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Programming: Object-oriented design; logic programming; Database design</td>
<td>✓✓✓</td>
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<td>✓</td>
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<tr>
<td>Robot arm operation</td>
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<tr>
<td>Causal reasoning in public policy</td>
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<td>✓</td>
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<tr>
<td>Psychology</td>
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<td>✓</td>
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<tr>
<td>Inquiry learning in sciences</td>
<td>✓✓</td>
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Methods for Assessment and Feedback in ITSs for Ill-Defined Domains

- Adaptive feedback on students’:
  - discussion posts based on simplified model of good posts, to tutee directly and indirectly via peer moderator (Walker, Ogan, Aleven, Jones)
  - selected actions in student-modified versions of pre-analyzed ethics narrative (Hodhod, Kudenko)

- Automatic generation of cloze (multiple choice) questions
  - with better-quality distractors (Pino, Heilman, Eskenazi)

- Compare student’s:
  - solution to template of solutions-plus-variations (Moritz, Blank)
  - problem-states-visited with mined patterns of partial problem spaces (Fournier-Viger, Nkambou, Mephu Nguifo)
  - diagrammatic reconstructions of arguments in terms of feedback-related features (Lynch, Pinkwart, Ashley, Aleven)

- Support self-assessment with expert decision map, visual representation of overall problem-solving process (Gauthier, Naismith, Lajoie, Wiseman)
<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Presentations</th>
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<tr>
<td>9:00 - 9:15</td>
<td><strong>Introduction:</strong> Kevin D. Ashley</td>
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</table>
| 9:15 - 10:15 | **Opening Session**                                                     | 1. *Two Approaches for Providing Adaptive Support for Discussion in an Ill-Defined Domain* Erin Walker, Amy Ogan, Vincent Aleven, Chris Jones  
2. *Interactive Narrative and Intelligent Tutoring for Ethics Domain* Rania Hodhod and Daniel Kudenko |
| 10:15 - 10:35 | **Coffee Break**                                                        |                                                                                                         |
| 10:35 - 12:15 | **Prelunch Session**                                                    | 1. *A Selection Strategy to Improve Cloze Question Quality* Juan Pino, Michael Heilman, and Maxine Eskenazi  
2. *Generating and Evaluating Object-Oriented Designs for Instructors and Novice Students* Sally Moritz and Glenn Blank  
3. General Discussion                                                                 |
| 12:15 - 1:30 | **Lunch**                                                            |                                                                                                         |
| 1:30 - 2:30  | **Post-lunch Session**                                                 | 1. *A Sequential Pattern Mining Algorithm for Extracting Partial Problem Spaces from Logged User Interactions* Philippe Fournier-Viger, Roger Nkambou and Engelbert Mephu Nguifo  
| 2:30 - 2:50 | **Tea Break**                                                         |                                                                                                         |
| 2:50 - 4:00  | **Closing Session**                                                    | 1. *Using Expert Decision Maps to Promote Reflection and Self-Assessment in Medical Case-Based Instruction* Geneviève Gauthier, Laura Naismith, Susanne P. Lajoie, and Jeffrey Wiseman  
2. Closing Discussion                                                                 |

*Paper presentations: 20 minutes each with 10 minutes for questions and discussion.*