Educational Technologies WS2006

Interactive Exercises

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Approximate Plan of the Course

18.10. Introduction
25.10. Introduction to ActiveMath
XML- Knowledge Representation
8.11. Student Modelling
15.11. Web technologies and security
22.11. Tutorial Planning and instructional design
29.11. Media Principles
6.12. Interactive exercises
13.12. Authoring tools, CTAT
20.12. Diagnosis: model tracing and domain reasoning

10.1. Diagnosis: constraint based
17.1. Tutorial dialogues
24.1. Action analysis and Machine Learning techniques
31.1. Cognitive tools
7.2. Meta-cognitive support
14.2. student projects

Overview on this Lecture

- **Existing Approaches**
  - Exercises in CAI systems
  - ITS Exercises
- **ActiveMath approach**
  - Exercise System Architecture
  - Knowledge Representation
  - Tutorial Strategies
  - Exercise Generation

Computer-Aided Instruction (CAI) or CAL

- store and retrieve data, exercise bank with answers
- pre-defined branches of problem solving
- no ‚understanding' of problems, few anticipated wrong answers
- Independent of student's understanding, preferenes, behaviour
- linear (not individualized) progression of instruction
- no diagnosis of errors

Authoring Tools

- **It is hard to Program each exercise**
- **Generic markup languages describe exercises**
  - QTI1
  - QTI2, MathQTI
- **Authoring tools help constructing exercises**
  - Many authoring tools for QTI1
  - Tools for QTI2 in progress
  - Mqat for MathQTI
- **Still for sensible exercise all answer possibilities have to be encoded for a question (lack of semantic expertize)**

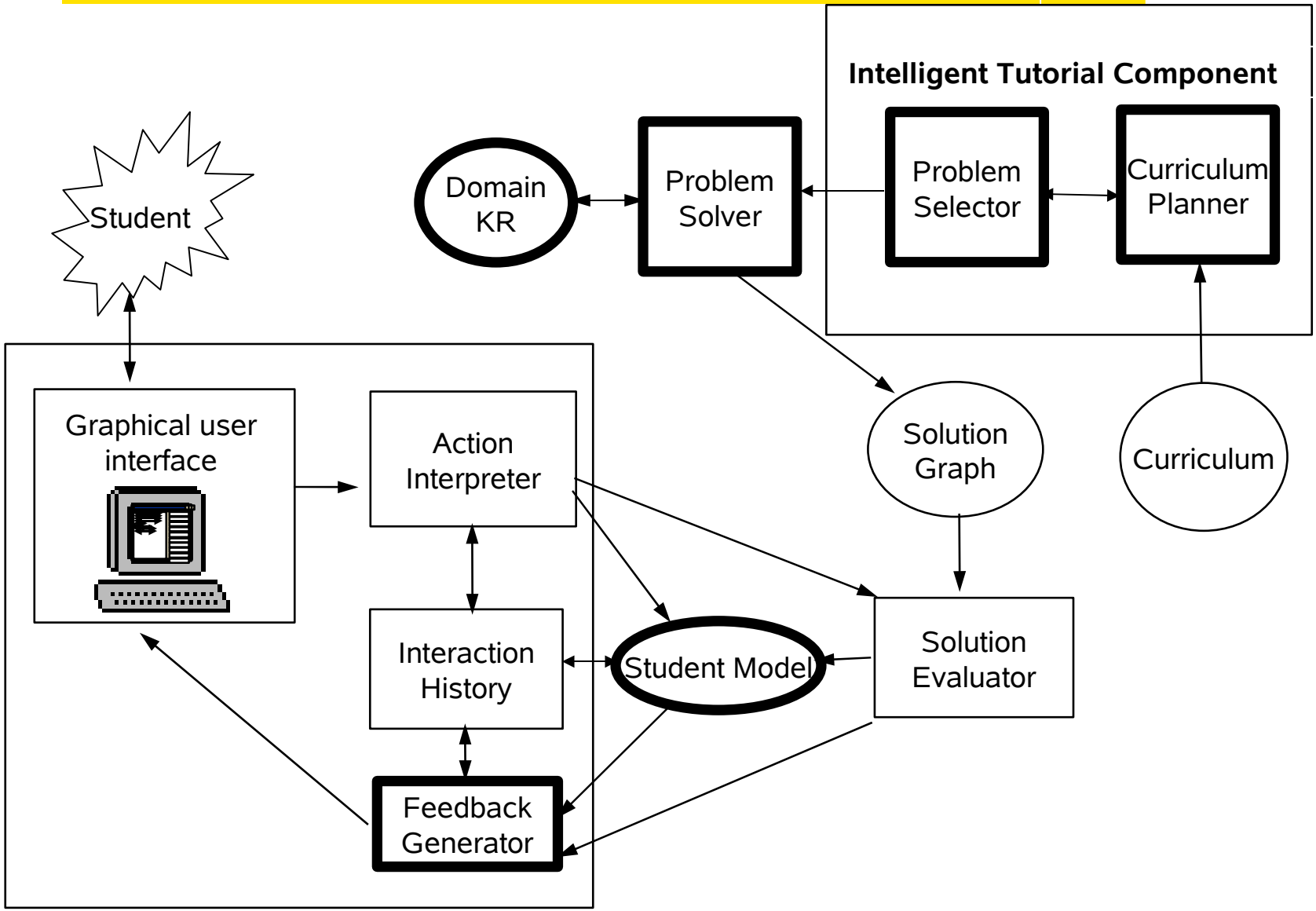
Intelligent Tutoring Systems (IST)

- Domain Expert Module
  - **Domain reasoner, generating solution paths**
  - **Possibly generating erroneous paths**
- Student Model
- Tutoring module

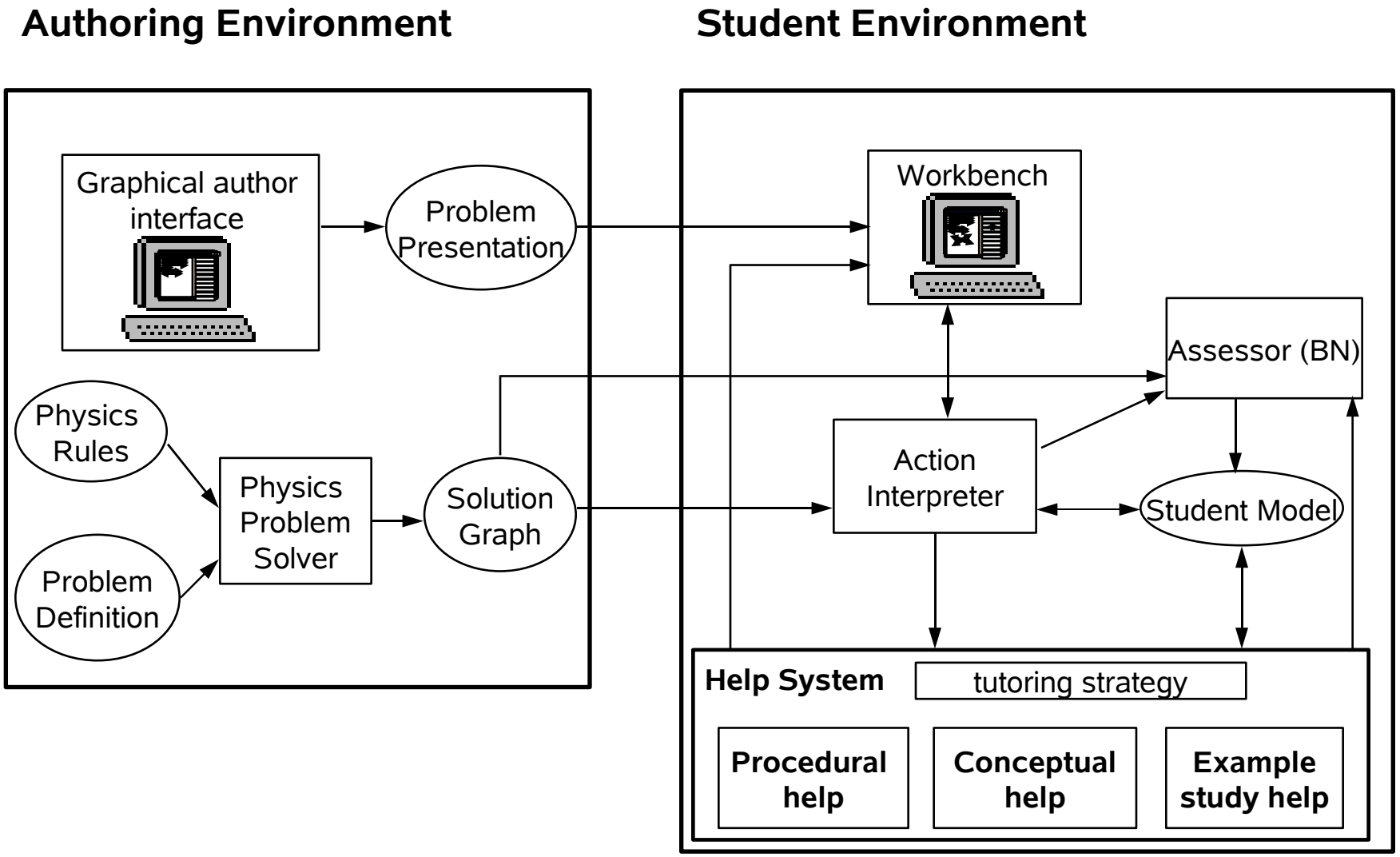
Examples.

- **ANDES – (van Lehn et al)**
- **Cognitive Tutors (Koedinger et al)**

A Generic ITS Architecture



Andes Architecture



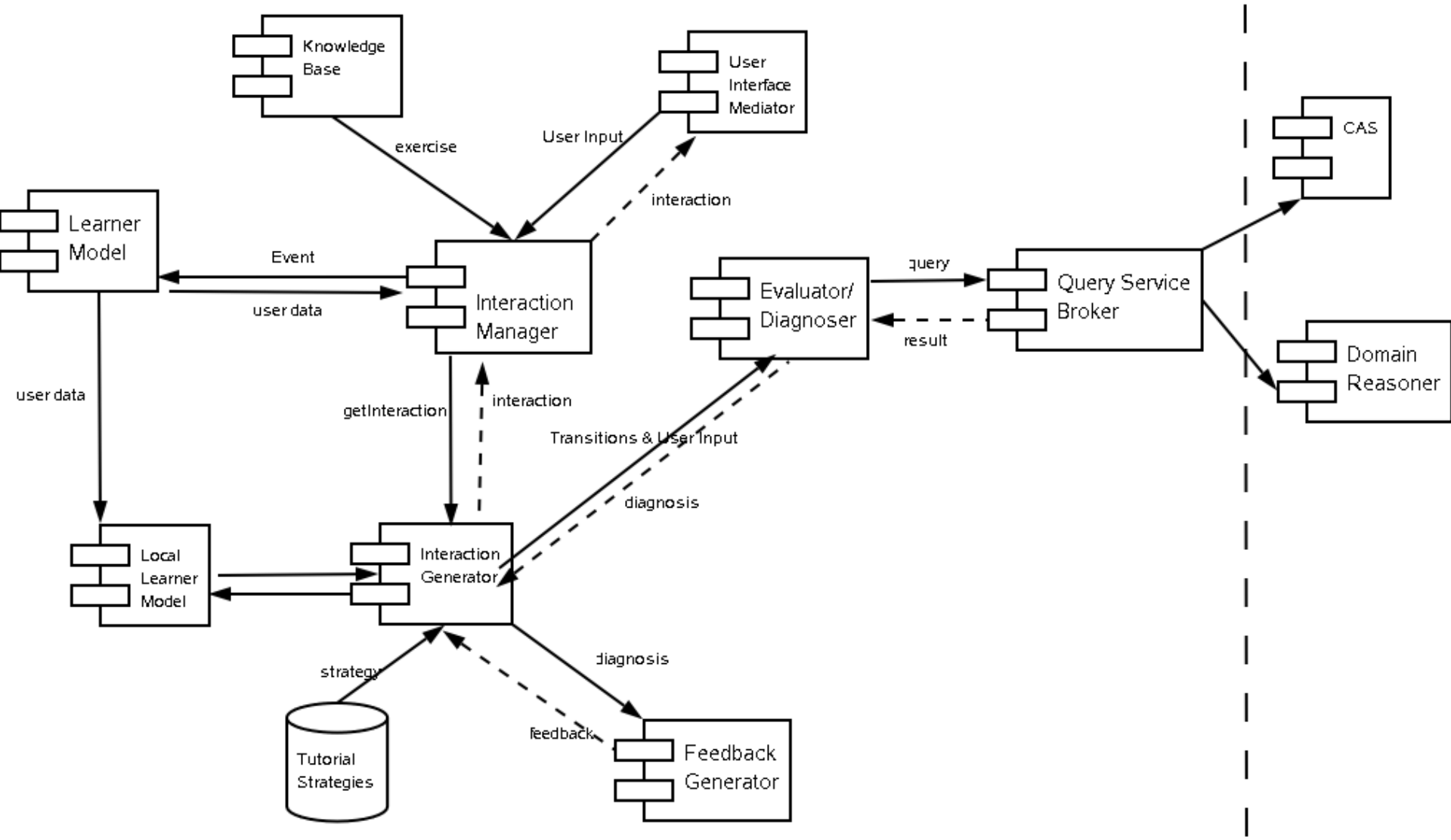
Authoring Tools for ITS

- CAI authoring tools are not enough
  - **Template based authoring suitable for manually authored exercises**
  - **Comlex domain model requires programming**
- Domain Expert Module has to be implemented
- Student model has to be programmed
  - **In principle domain independent procedure**
  - **But for each domain it has to be programmed**
- Tutoring module
  - **In principle domain independent**
  - **Tutorial strategies differ dependent on the domain**
- Interface depends on the domain as well
  - **e.g. ANDES interface is suitable for physics problems**
  - **Generic interface would be too complex**
- In practice
  - **ITS has to be programmed separately for each domain**
  - **Very expensive**
  - **Requires developers to be domain experts and pedagogists**
- No more human control possible

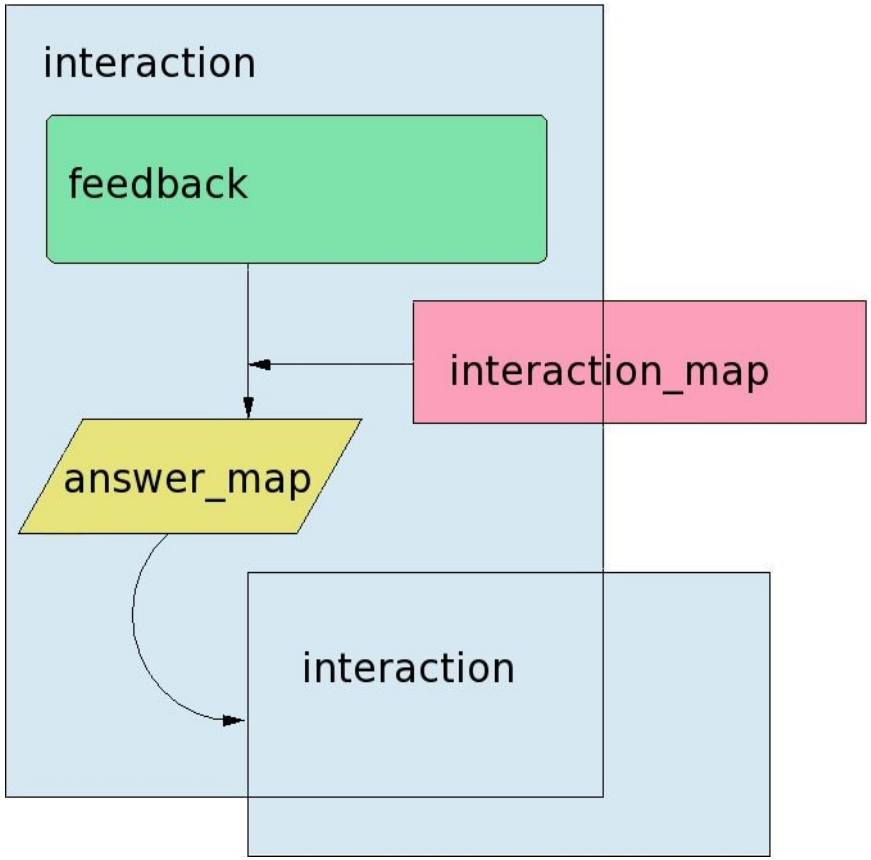
ActiveMath Approach

- **Exercises were originally manually authored**
  - Rich knowledge representation for manual authoring
- **More diagnosis was necessary**
  - Employing Computer Algebra Systems (CAS)
  - Connecting to External Domain Reasoners
- **More feedback was necessary**
  - generating feedback based on intelligent diagnosis
  - designing automatic feedback strategies
- **More exercises were necessary**
  - encoding classes of exercises
  - generating exercises using Domain Reasoner

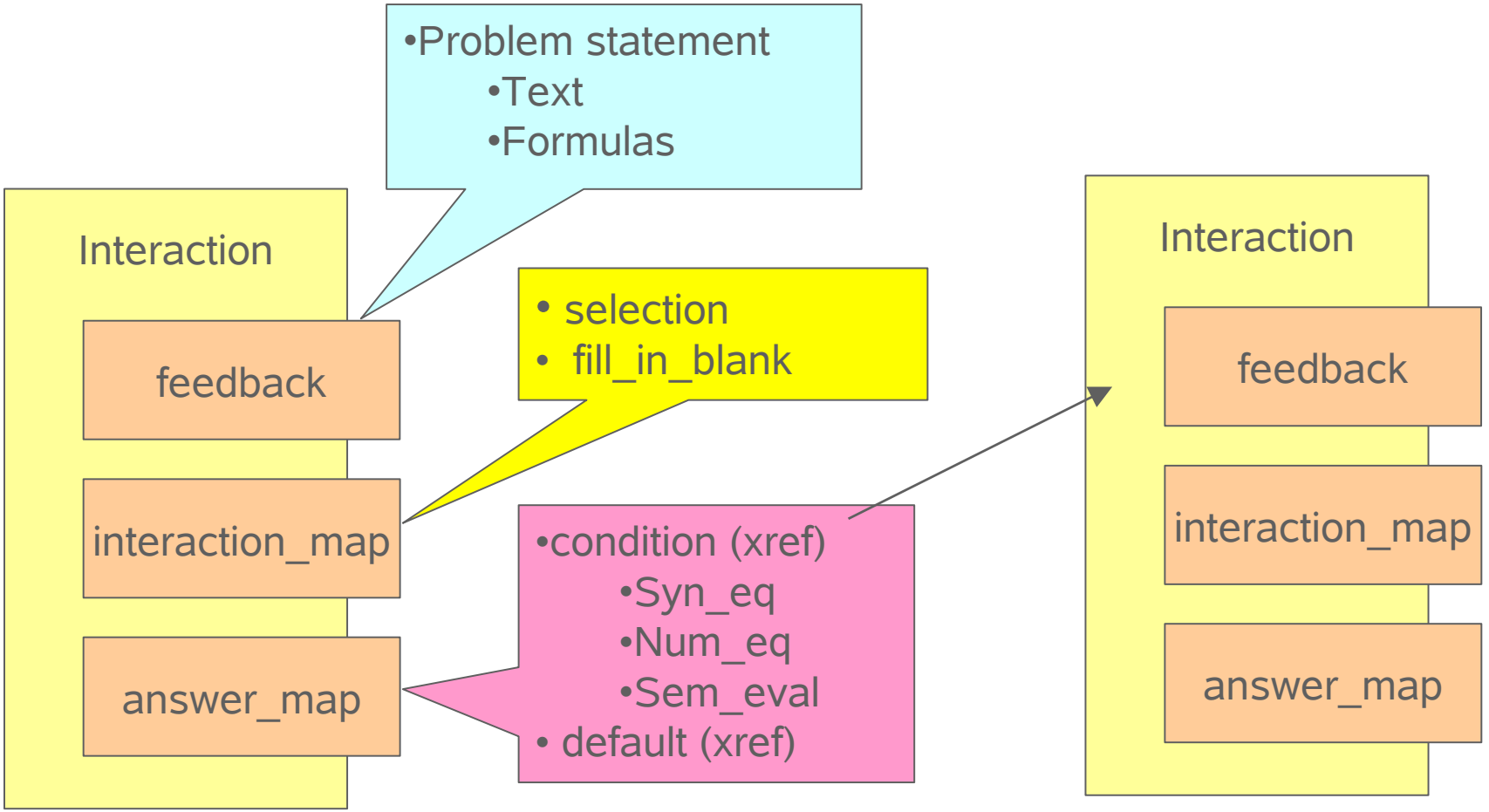
ActiveMath Exercise System Architecture



ActiveMath Exercise Knowledge Representation



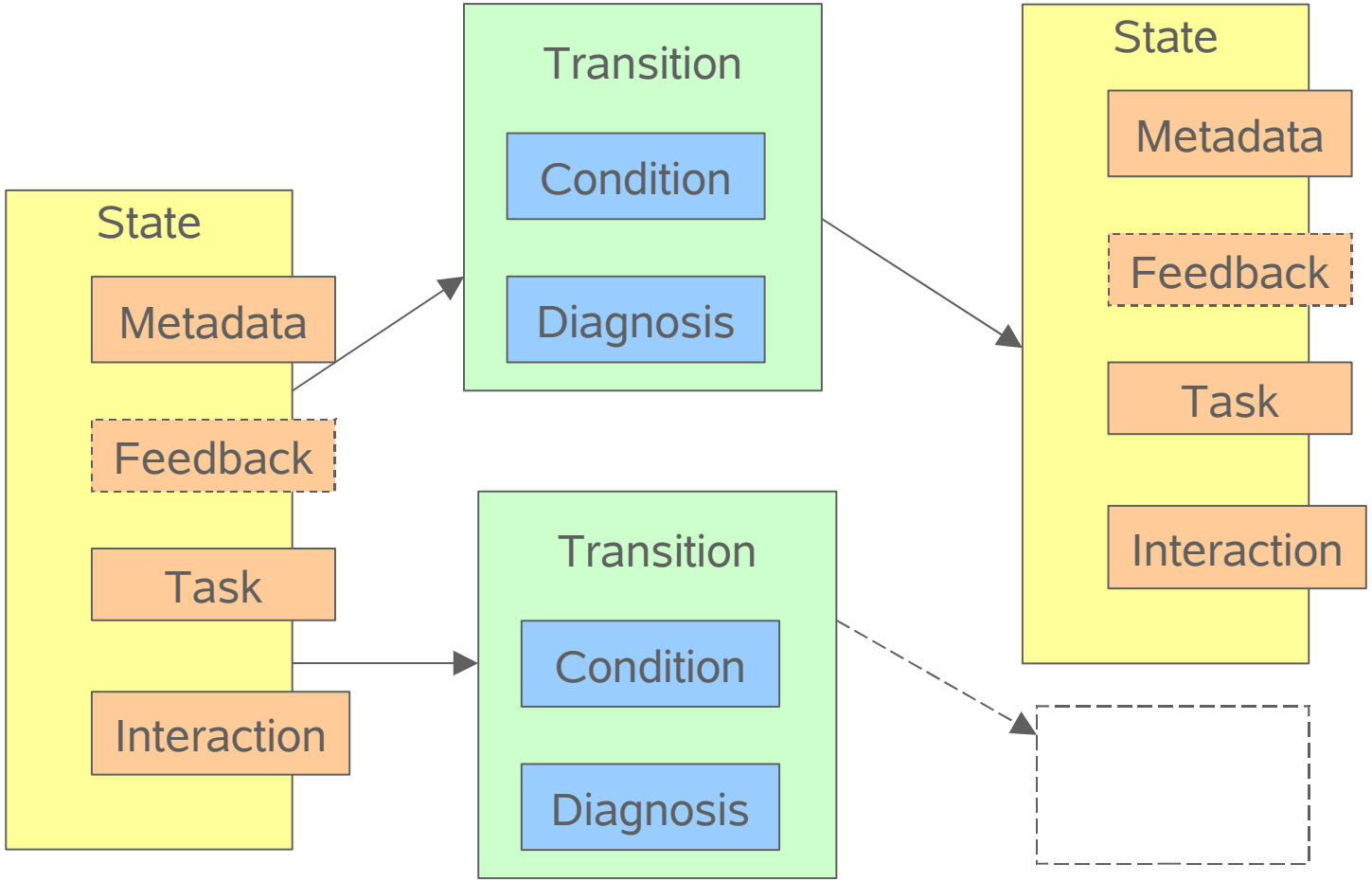
ActiveMath Exercise Knowledge Representation



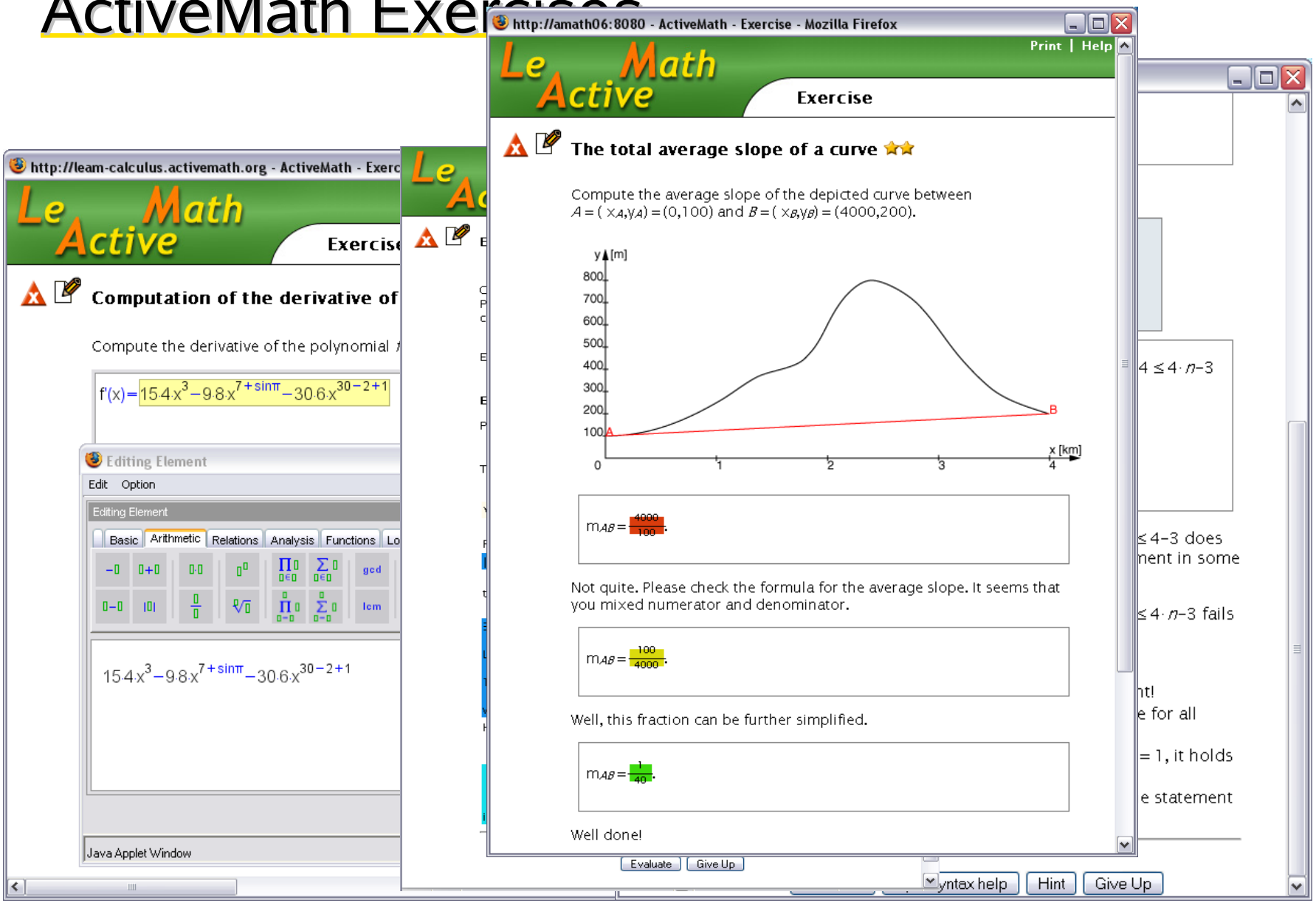
ActiveMath Exercise Knowledge Representation

Sample Source Code

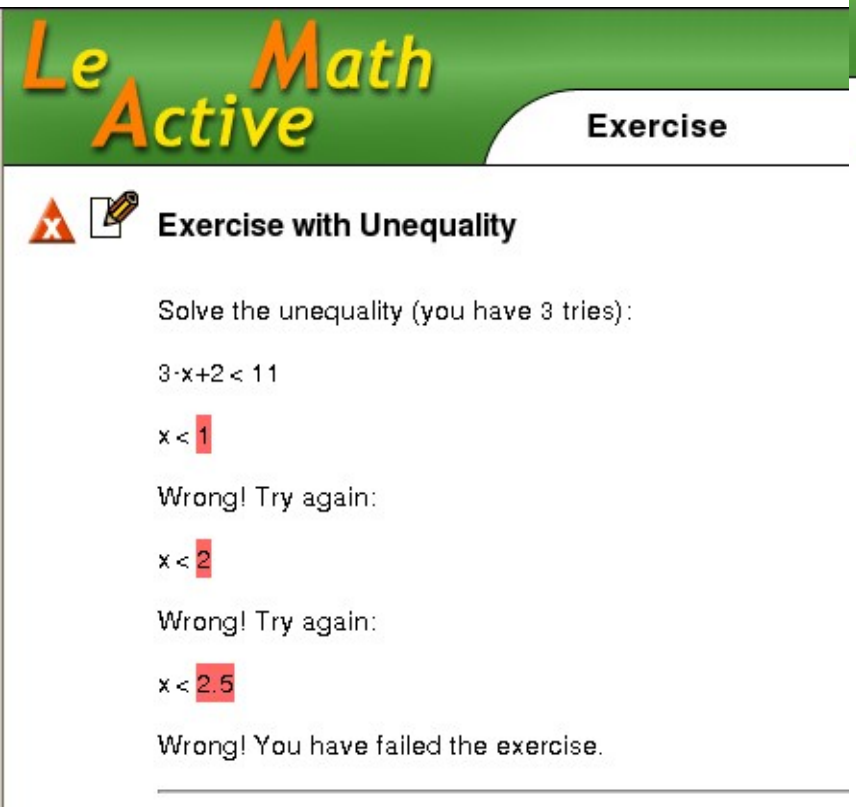
Future Exercise Knowledge Representation

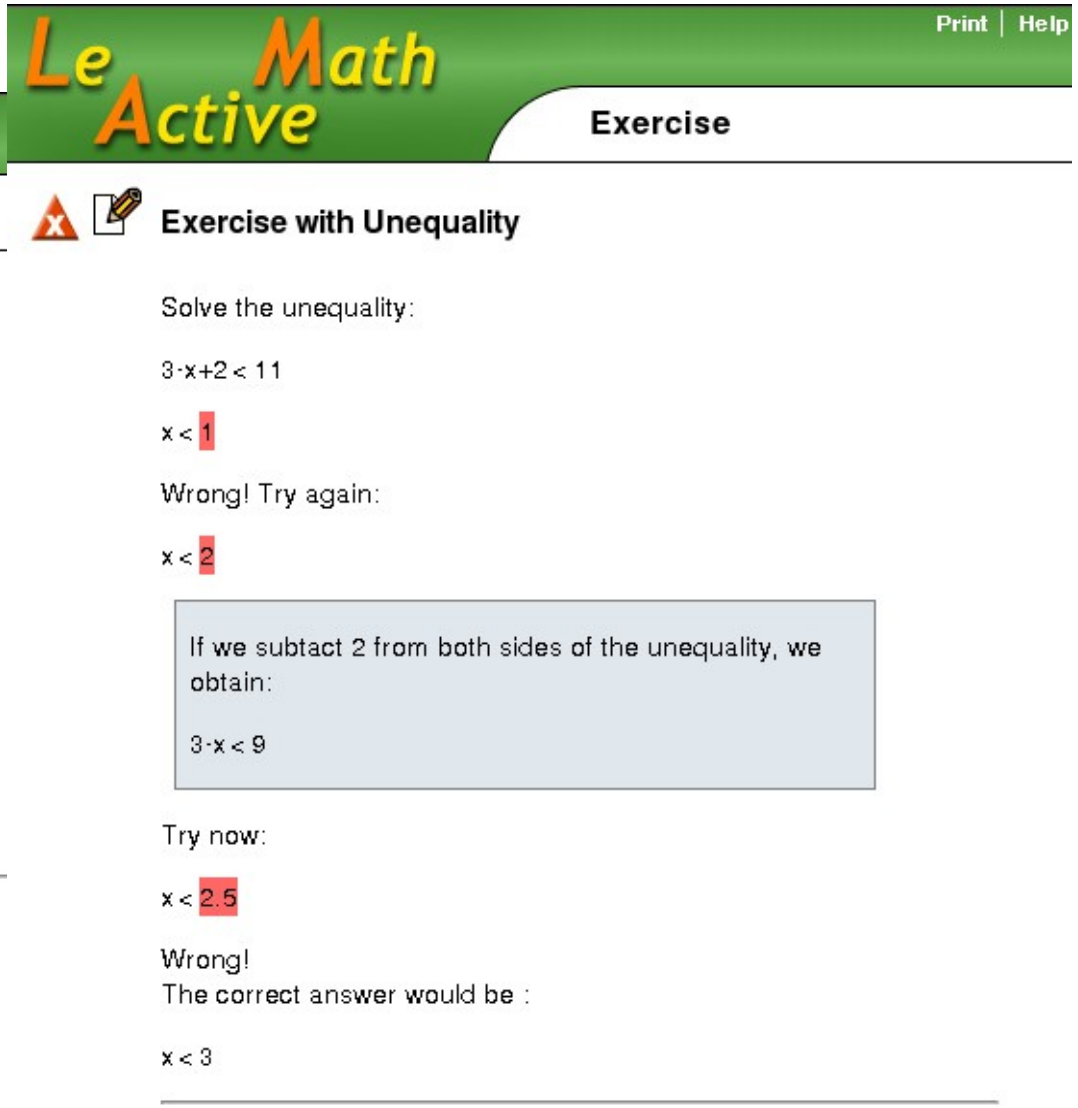


ActiveMath Exercises

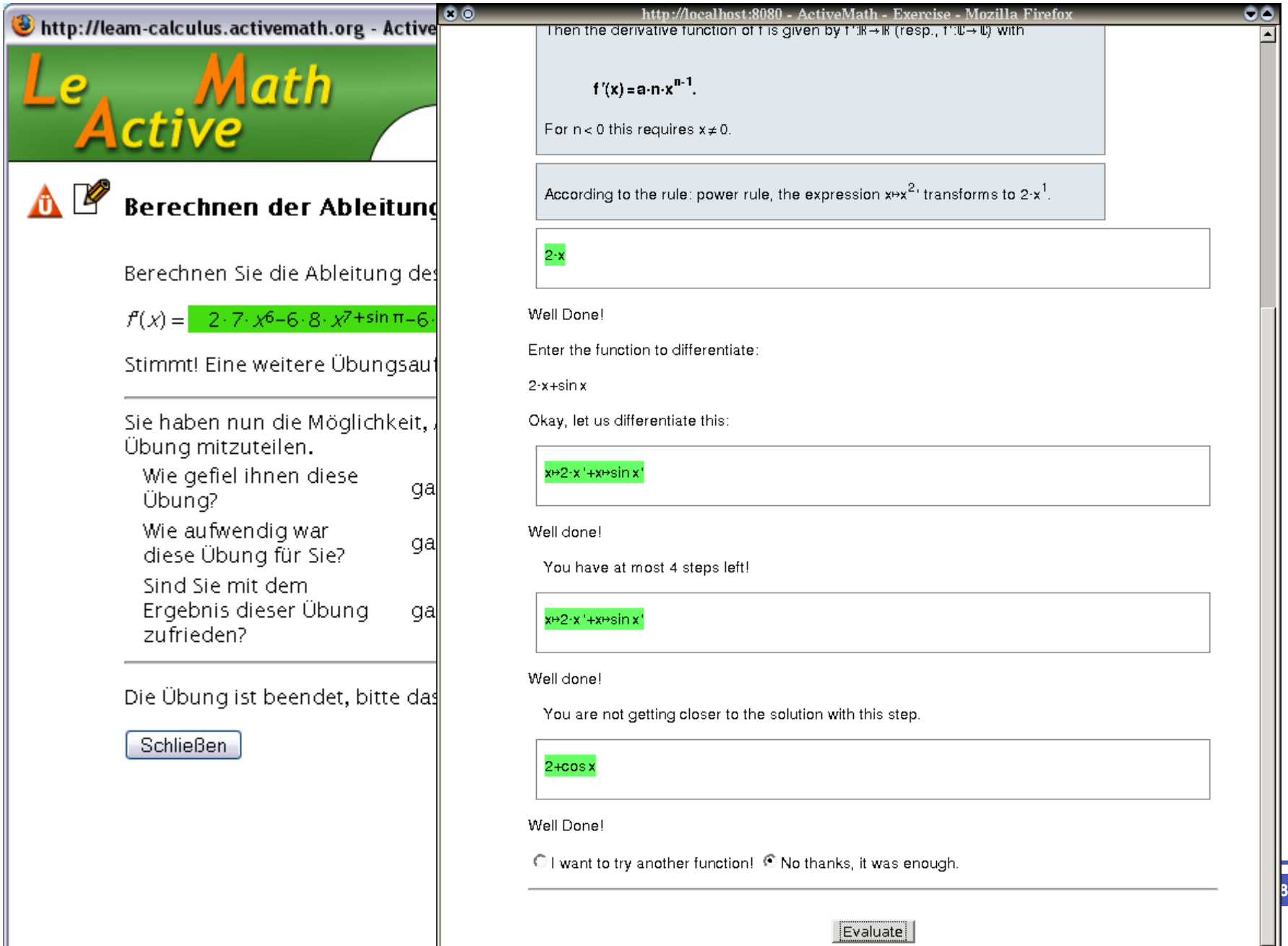


Tutorial Strategies





Exercise Generation



Authoring an Exercise

- Interactive Demo with Exercise Authoring Tool