Wisdom is not the product of schooling but the lifelong attempt to acquire it.
- Albert Einstein

Integrating Self-Directed Learning and Contextualized Tutoring

Gerhard Fischer

Presentation, L3D Meeting, April 21, 2004

Abstract

- **Self-Directed Learning** and **Tutoring** both have their strength and weaknesses.

- By integrating the two approaches including
  - providing support mechanisms for self-directed learning and
  - contextualizing tutoring to the task at hand and
  - by supporting this approach with effective media, technologies, and human infrastructure,

  powerful learning environments can be constructed fitting the needs of the learning societies of the future.

Overview

- **objectives**

- **examples** of tutoring and self-directed learning
  - tutoring: inner game of tennis
  - self-directed learning: learning probability theory in context
  - “How the West was Won”
  - high-functionality application
  - reflection-in-action

- **learning**: some characteristics and theories

- **challenges** associated with self-directed learning and tutoring

Global Objective: Guided Discovery Learning

- "students need enough **freedom** to become cognitively active in the process of sense making, and students need enough **guidance** so that their cognitive activity results in the construction of useful knowledge" (Bruner)

- learning is more than being taught (Illich) → teaching is often *"fitted into a mold in which a single, presumably omniscient teacher explicitly tells or shows presumably unknowing learners something they presumably know nothing about"* (Bruner)

Lifelong Learning

- **phases:**
  - intuitive learner (home)
  - scholastic learner (school)
  - skilled domain worker (workplace)

- **lifelong learning is more than "adult education":** applicable to the educational experience of both children and adults
  - bring the child's experience closer to meaningful and personalized work
  - bring the adult's experience closer to one of continued growth and exploration

- **hypothesis:** tutoring most important for scholastic learner (school)

hypothesis: self-directed learning most important for skilled domain worker (workplace)
  - learning on demand
  - integration of working and learning
  - collaboration

Questions for Reflection

- contextualized tutoring is only possible within a context → and this context is provided by the (self-directed) activities of active learner (see McDonell research grant)

- is contextualized tutoring the same as guided discovery learning?

- is tutoring the same as instructionist teaching?

- is using clickers a form of contextualized tutoring?

- the major challenges
  - developing systems which are learner centered **and** supportive
  - capturing context and intent not at design time but at use time → planning ahead becomes a smaller part of the overall activity and it changes its nature (plan as a meta-designer, rather than as a designer)

Major Challenges

- developing systems which are learner centered **and** supportive

- **meta-design:**
  - capturing context and intent not at design time but at use time → planning ahead becomes a smaller part of the overall activity and it changes its nature (plan as a meta-designer, rather than as a designer)
  - books in principle do not (1) support meta-design (no dynamic access to the knowledge it contains (it can answer unexpected questions from the self-directed learner) and (2) modify their presentation on the fly to adapt themselves to a reader's specific needs
  - instead of decision/specific actions/specific problems resulting from some knowledge, it is the knowledge itself (domain modeling and domain construction) that it explicitly represented and evolved
  - meta-designers model domain, learners, communication process, problem solving knowledge

Example for Tutoring

- a standard, curriculum-driven set of lessons for
  - skiing, tennis
  - use of high-functionality applications (e.g., Word, Excel)

- **The Inner Game of Tennis by W. Timothy Gallwey**

Example of Self-Directed Learning

- an intermediate tennis player, skier
  - a standard curriculum is of little value

- identification of the task at hand:
  - objective by the self-directed learners: “I want to create more offensive pressure with by backhand”
  - often further refined by the coach playing with the learner for a few minutes (may include the creation of specific situation to further refine the learner’s objective)

- a intermediate user of a high-functionality application (e.g., MS-Office, Photoshop, software reuse library)

Examples for Self-Directed Learning
—
A Real Story about Learning

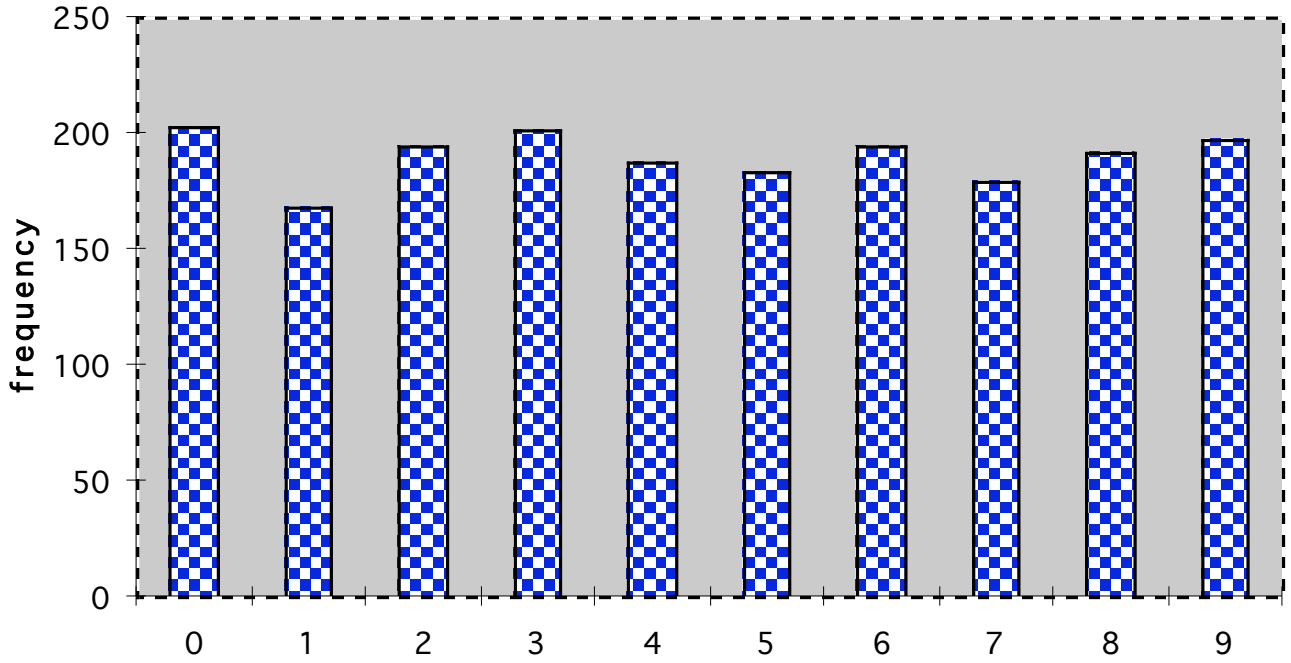
- course for gifted high-school students
- student$_X$: no interest in math
- project: computer-generated poetry
- sentence structure: <article> <adj> <noun> <verb> <art> <noun>
- noun: = "house mouse spouse ....."
- use of a random number generator which returns values between 0 and 9
- noun list contains 18 objects ----> student$_X$ uses: SUM RANDOM RANDOM

A Computer-Generated Poem — Der Dumme Student

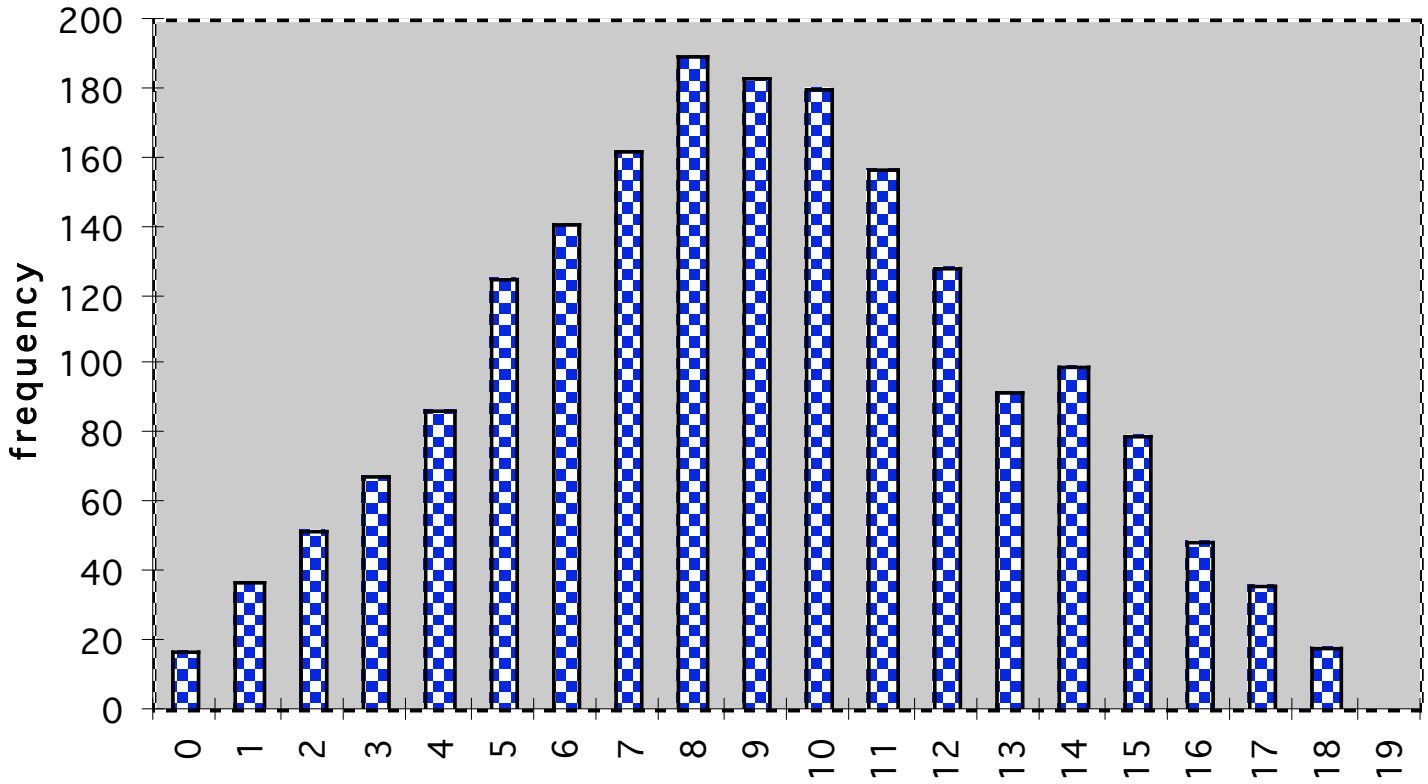
Das dumme Stubenmaedchen verflucht die Schlampe
das lustige Kindermaedchen verbrennt keine Pampe
jedes kluge Maedchen ionisiert den Tresen
ein verschrumpeltes Maedchen verbrennt das Wesen
kein ausgereifter Professor kocht den Wurm
kein aufgespiesster Student besteigt den Turm.

Der kleine Hausmeister elektrisiert einen Ball
jedes schweinslederne Maedchen seziert einen Knall
der gefriergetrocknete Bergsteiger erfreut das Bier
jede erdrosselte Jungfrau untersucht einen Stier
ein kleiner Computer massakriert jede Flasche
jeder erdrosselte Mann bearbeitet die Asche.

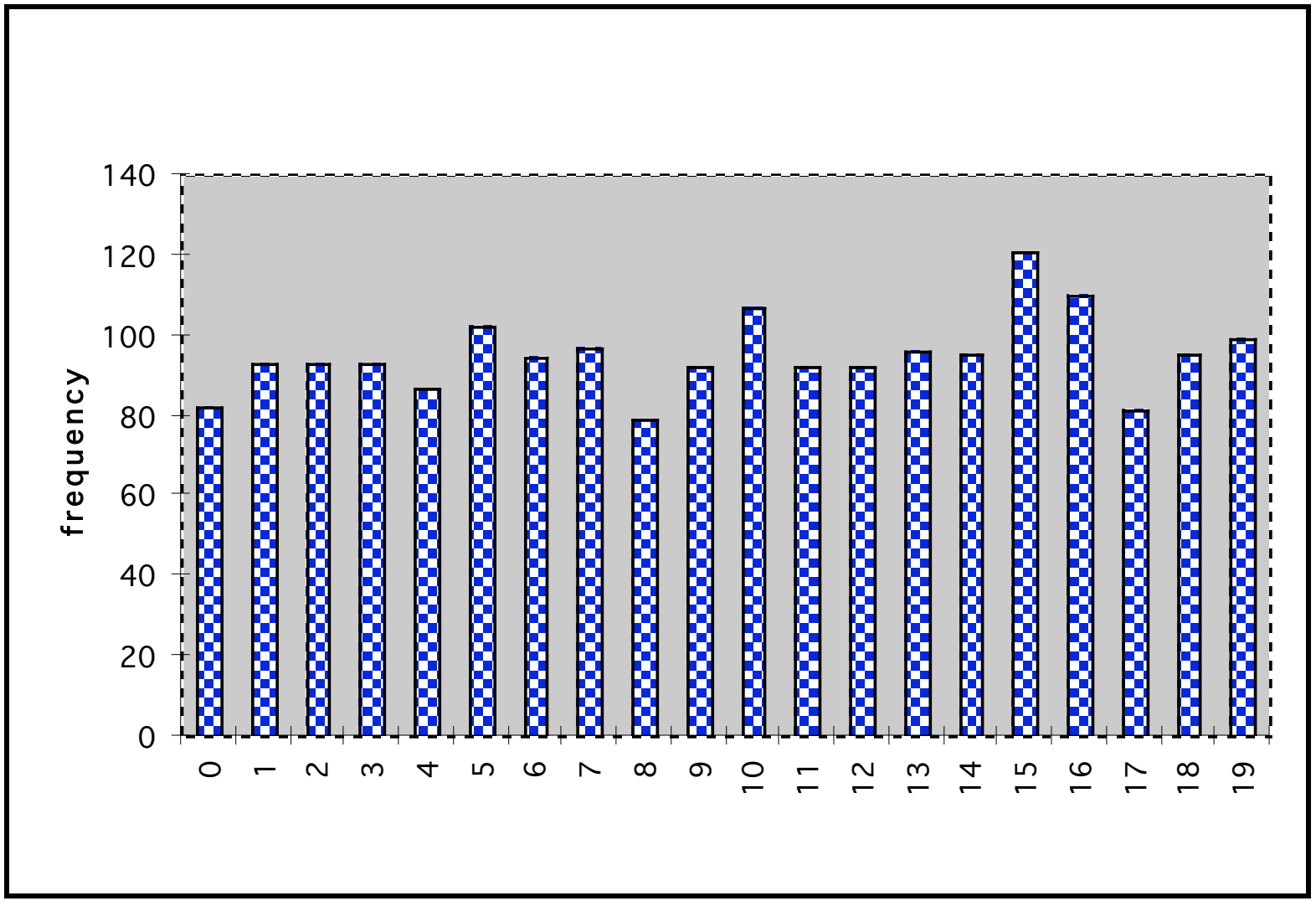
Random 0 to 9



Sum of Random and Random



Word of Random and Random



Lessons to Be Learned from the Story

- student$_x$ learned some aspects of probability theory grounded in a self-directed learning activity

- provide opportunities which change people's lives
  - intrinsic motivation is crucial
  - "falling in love" with something → student$_x$ ended up studying computer science

- "normal" learning experience: learners work hard because they ***have*** to (extrinsic motivation)

- our goal: learners work hard because they ***want*** to(intrinsic motivation)

Example: "How the West Was Won"

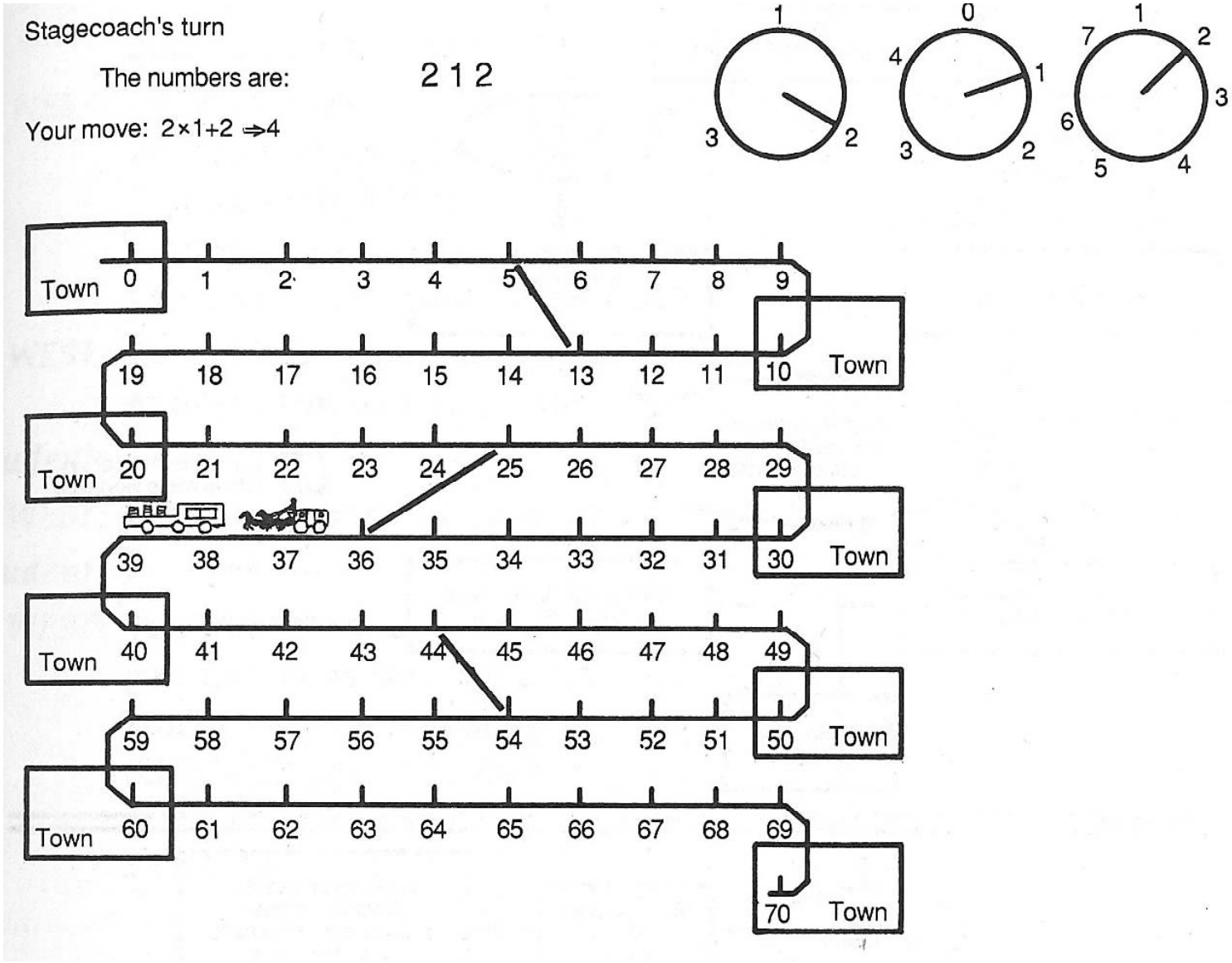
- **source**: Burton, R. R., & Brown, J. S. (1982) "An Investigation of Computer Coaching for Informal Learning Activities." In D. H. Sleeman, & J. S. Brown (Eds.), Intelligent Tutoring Systems, Academic Press, London - New York, pp. 79-98.

- West Coach = provides unobtrusive assistance while the student is involved in independent learning

- games as a domain
  - conceptual simplicity
  - "closed" and "well-defined" space
  - intrinsic motivational value

- the attractiveness / importance of contextualized tutoring:
  - learners (in self-directed learning activities) get stuck on "plateaus of proficiency"
  - the task of contextualized tutoring: not to lecture on unrelated issues, but to exploit the context by pointing out existing learning opportunities and by transforming failures into learning experiences

The Game Board



Example: "How the West Was Won"— Continued

- a very good example illustrating many of our objectives, but: the task domain is simple → p 96: "the world of WEST is sufficiently closed and small enough that an explicit enumeration of possible alternative strategies is possible"
  - a correct ("best move") answer exists
  - the "task at hand" can be "easily" inferred
  - the space of tutoring episodes is limited
  - the set of "issues" is known and defined at design time

- objective: computer-based tutoring/coaching systems to enhance the educational value of gaming environments (playing a game) by guiding a student's discovery learning

- informal learning environments (such as games)
  - enticing to the student by enabling him to control it
  - to be fully effective as a learning activity, it often must be augmented by tutorial guidance that recognizes and explains weaknesses in the students decisions or suggest ideas when the student appears to have none

Example: "How the West Was Won"— Continued

- the tutor or coach must be perceptive enough
  - to make relevant comments
  - but not as intrusive enough as to destroy the fun inherent in the game

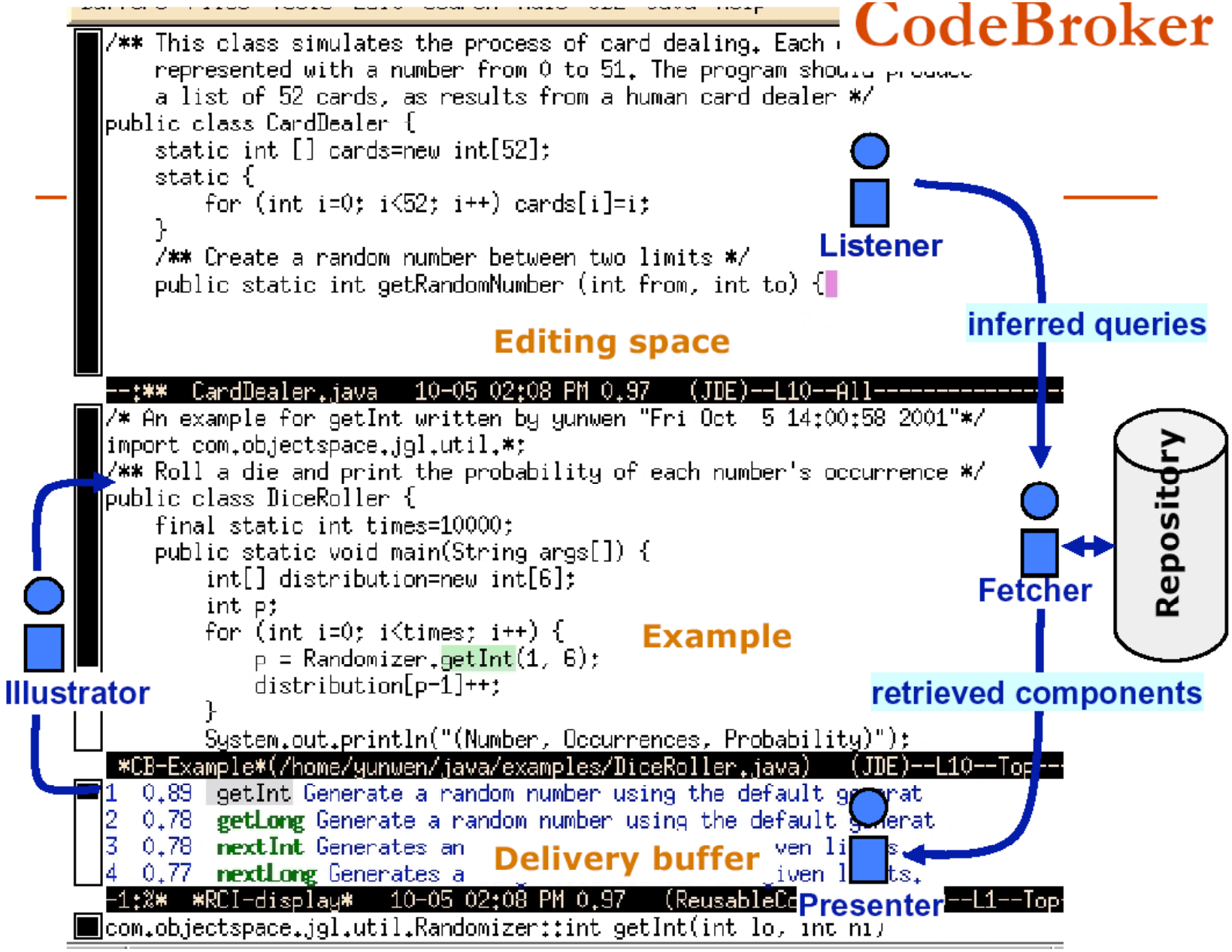
- Issues and Examples: Issues Recognizer and Issues Evaluator

- assessment:
  - the coached group enjoyed playing the game much more

High-Functionality Applications
—
MS-Office, Photoshop, Software Reuse Libraries, McGuckin

- why are they an interesting application domain?
  - people use them but only partially know them
  - new functionality is learned in self-directed learning processes and supported by learning on demand

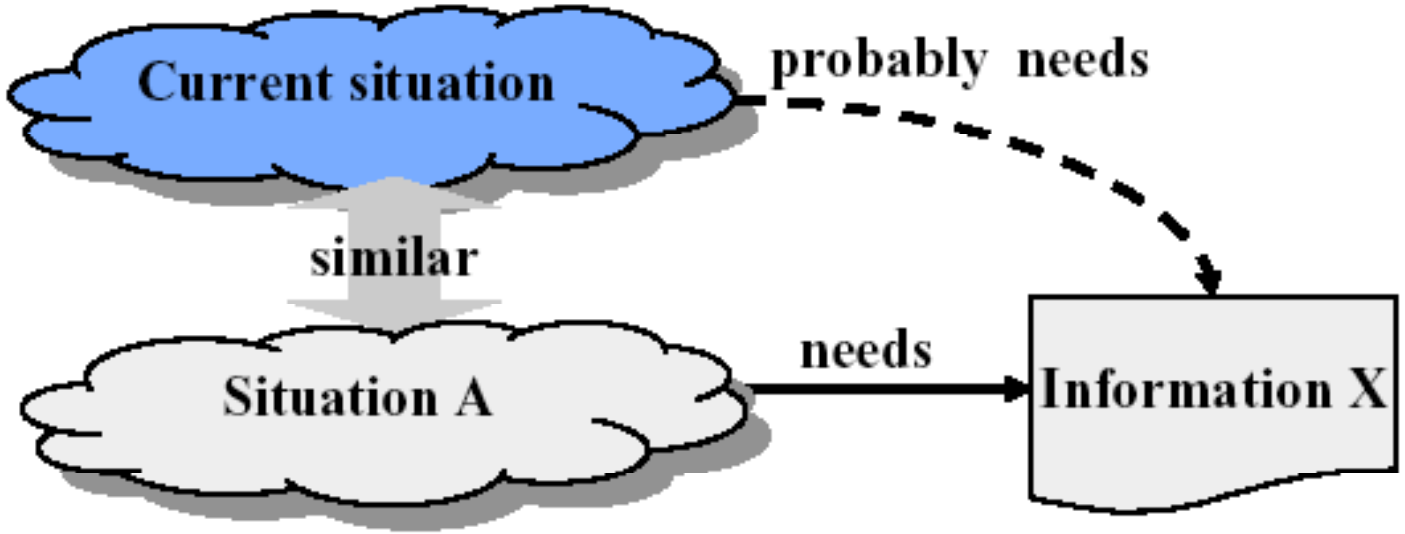
- example: CodeBroker


CodeBroker
/** This class simulates the process of card dealing. Each
represented with a number from 0 to 51. The program
a list of 52 cards, as results from a human card dealer */
public class CardDealer {
static int [] cards=new int[52];
static {
for (int i=0; i<52; i++) cards[i]=i;
}
/** Create a random number between two limits */
public static int getRandomNumber (int from, int to) {
Listener
inferred queries
Editing space
--:** CardDealer.java 10-05 02:08 PM 0.97 (JDE)--L10--All
/* An example for getInt written by yunwen "Fri Oct 5 14:00:58 2001"*/
import com.objectspace.jgl.util.*;
/** Roll a die and print the probability of each number's occurrence */
public class DiceRoller {
final static int times=10000;
public static void main(String args[]) {
int[] distribution=new int[6];
int p;
for (int i=0; i<times; i++) {
p = Randomizer.getInt(1, 6);
distribution[p-1]++;
}
System.out.println("(Number, Occurrences, Probability)");
Repository
Fetcher
Example
Illustrator
retrieved components
CB-Example(/home/yunwen/java/examples/DiceRoller.java) (JDE)--L10--Top
1 0.89 getInt Generate a random number using the default
2 0.78 getLong Generate a random number using the default
3 0.78 nextInt Generates an
4 0.77 nextLong Generates a
Delivery buffer
Presenter
-1:2* *RCI-display* 10-05 02:08 PM 0.97 (ReusableCo --L1--Top
com.objectspace.jgl.util.Randomizer::int getInt(int lo, int hi)

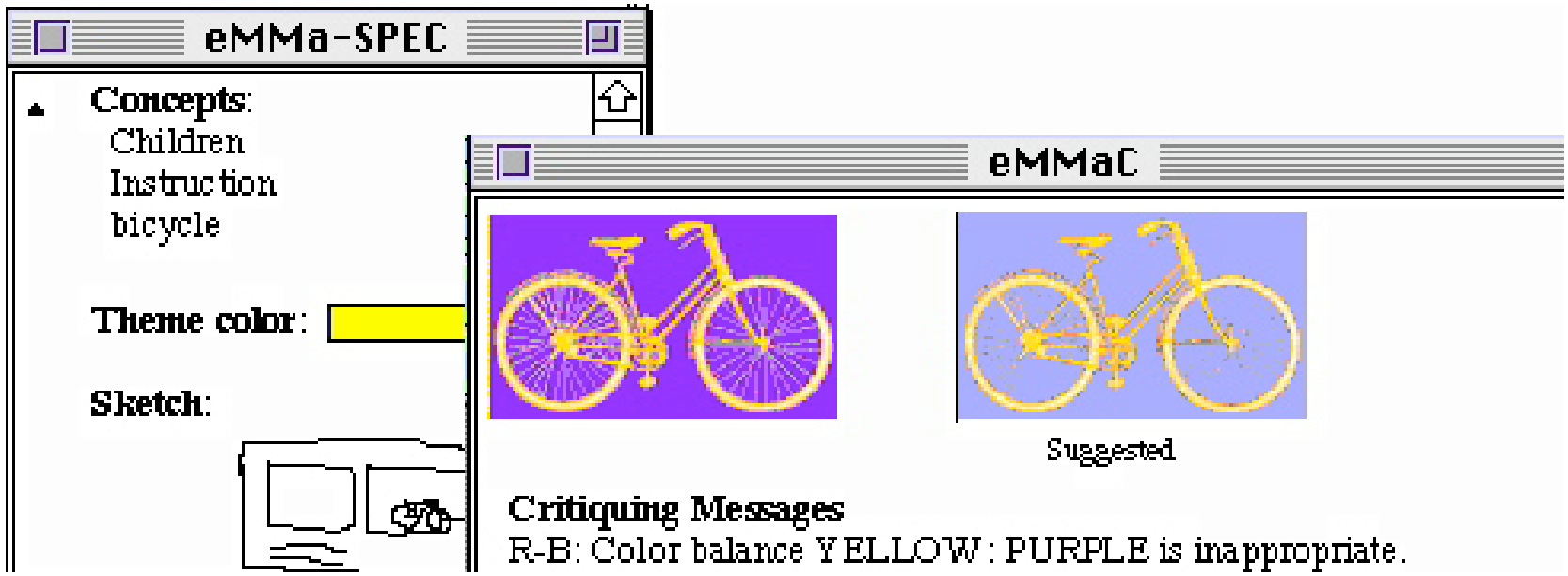
Inferring the Task

- Plan recognition
  - Actions → Inferred goal → Suggested actions or information

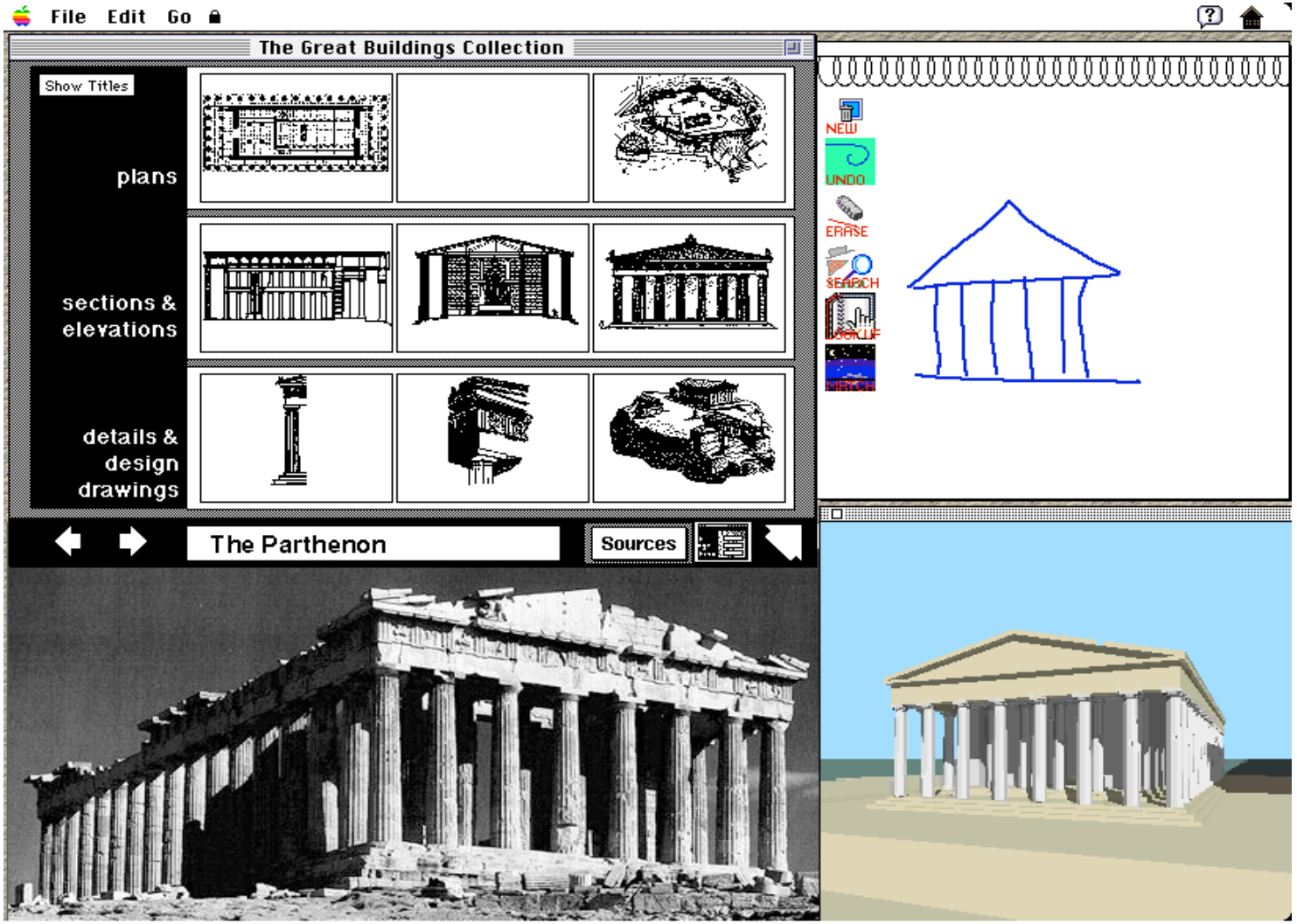
- Similarity analysis



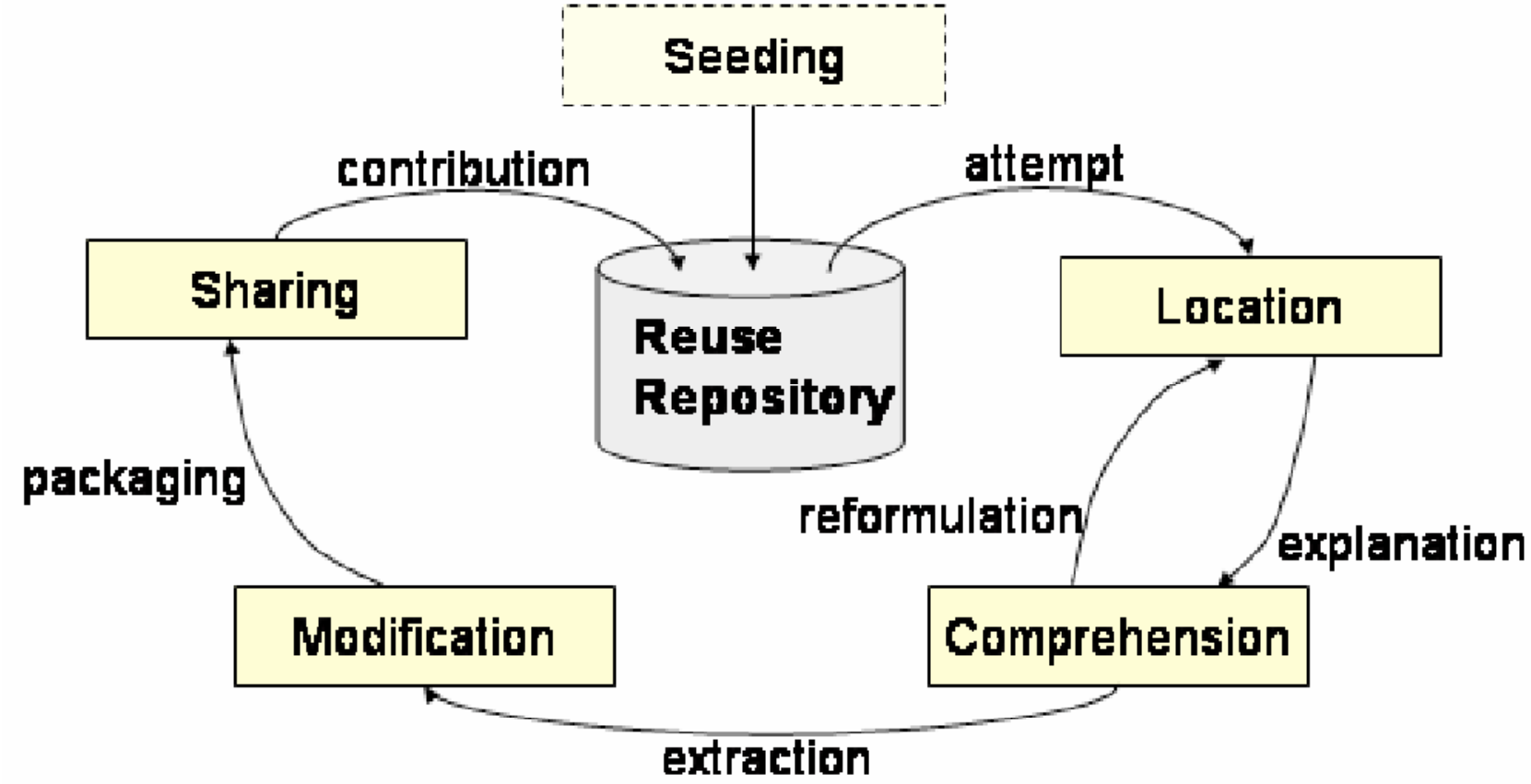
Specification Sheets as Intention Articulation



Sketches as Intention Articulation

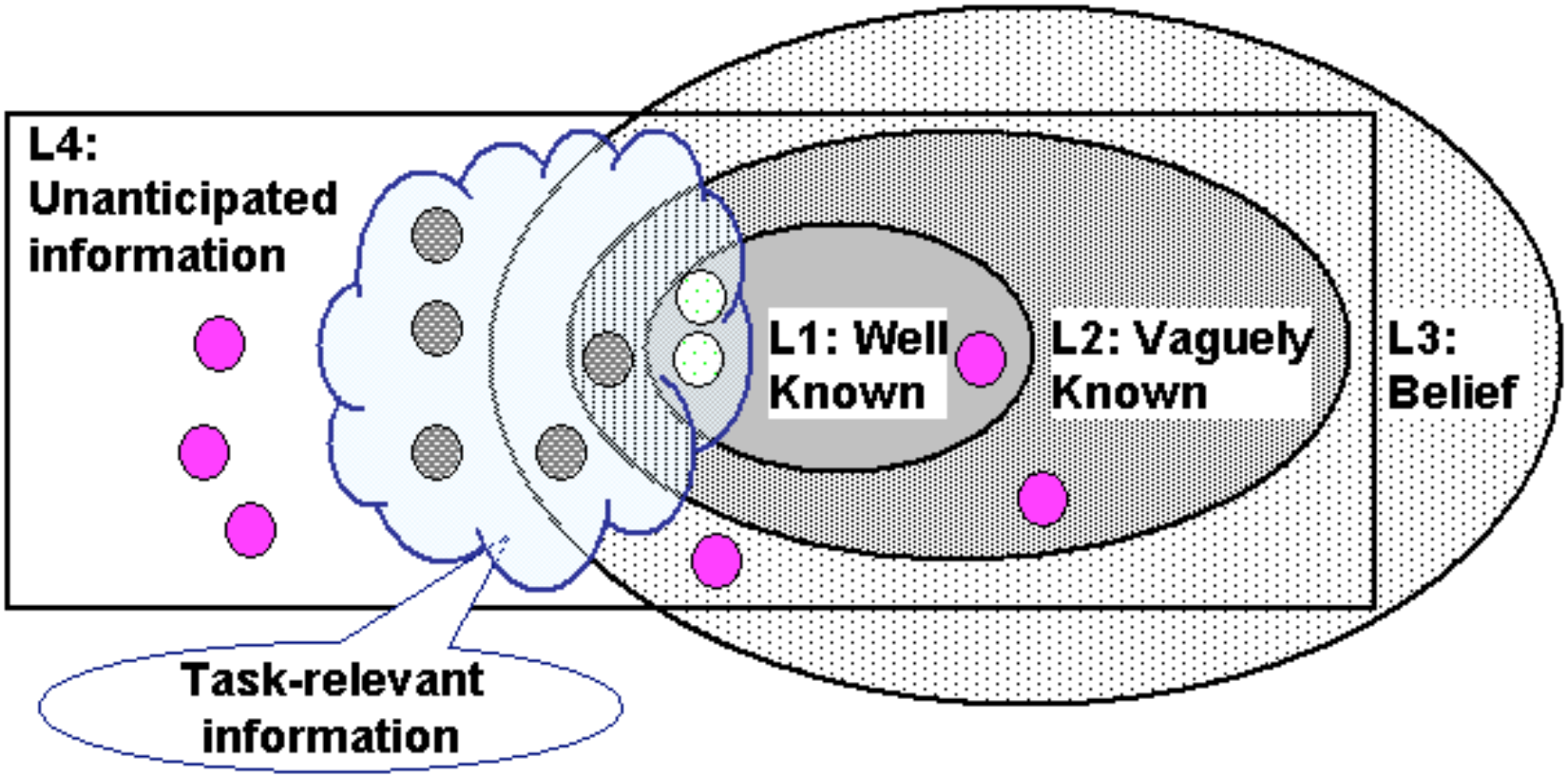


Enriching the Reuse Process with Contextualized Tutoring



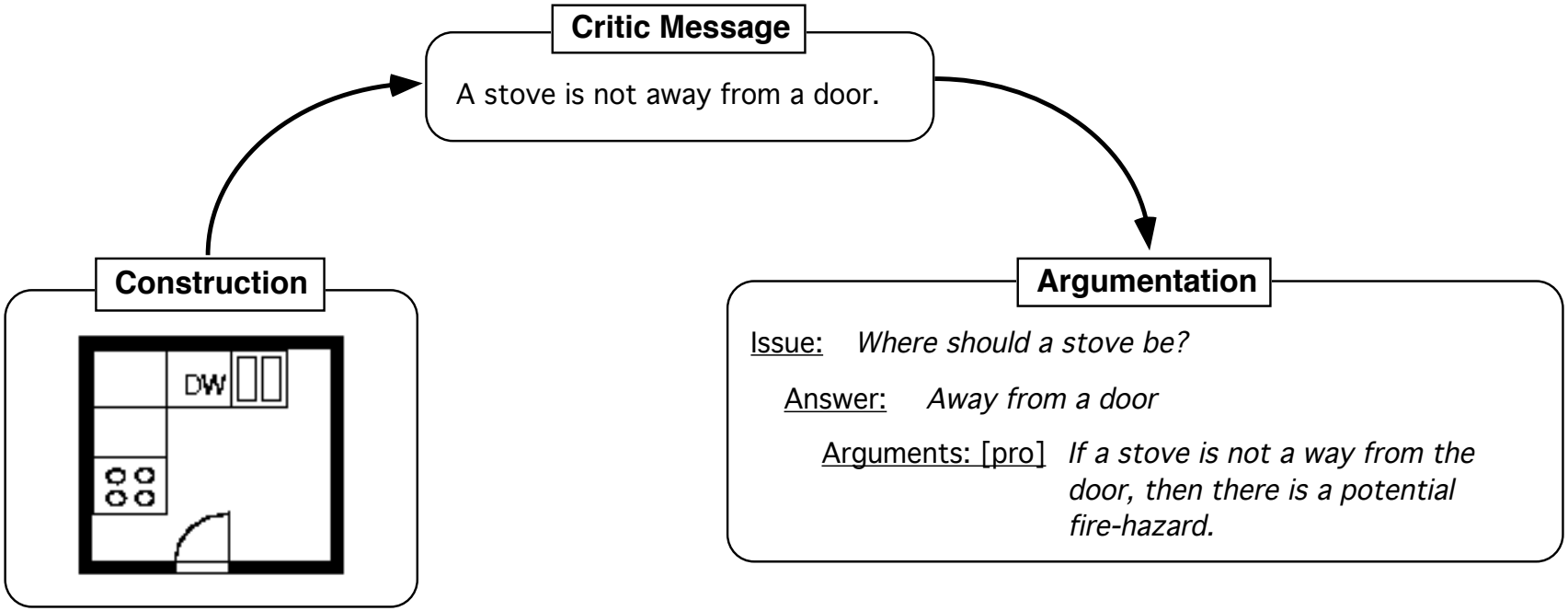
User Modeling and Identification of the Task at Hand in HFAs

Why “Did You Know (DYK)” and “MS Tip of the Day” are of limited success



Reflection-in-Action and Contextualized Tutoring
—
Integration of Construction and Argumentation in JANUS

- The critiquing mechanism in JANUS identifies a potential problem in the *construction* component. A displayed critic message is linked to the *argumentation* component, where further explanation of the potential problem and alternate solutions can be found → contextualized tutoring could extend this further, including illustrating issues with the Argumentation Illustrator



Some Claims about Learning

- people learn best when engrossed in the topic, motivated to seek out new knowledge and skills because they need them in order to solve the problem at hand

- real learning
  - the way we learn is trying something, doing it, and getting stuck
  - the same piece of information that made no impact at a lecture makes a dramatic impact when we're ready for it

- learning and teaching are not inherently linked:
  - much learning takes place without teaching
  - much teaching takes place without learning

- learning is **knowledge-dependent**; people use their existing knowledge to construct new knowledge — the knowledge which a learner has shows up in self-directed learning activities (support for taking knowledge-dependency into account: differential descriptions, user models, personalization)

Passion for Learning — Beyond Tests

COMMENTARY • OPEN FORUM

Tuesday, May 2, 2000

Tutoring ←→ Self-Directed Learning

Tutoring		Self-Directed Learning
there is a "scientific," best way to learn and to work (programmed instruction, computer-assisted instruction, production lines, waterfall models)	→	real problems are ill-defined and wicked; design is argumentative, characterized by a symmetry of ignorance among stakeholders
separation of thinking, doing, and learning	→	integration of thinking, doing, and learning
task domains can be completely understood	→	understanding is partial; coverage is impossible
objective ways to decompose problems into standardizable actions	→	subjective, situated personal interests; need for iterative explorations
all relevant knowledge can be explicitly articulated	→	much knowledge is tacit and relies on tacit skills
teacher / manager as oracle	→	teacher / manager as facilitator or coach

The Complementary Nature of Self-Directed Learning and Tutoring

	Tutoring	Self-Directed Learning
characteristics	learning supported from the supply side adult-run education prescriptive	learning supported from the demand side child-run education permissive
strength	organized body of knowledge pedagogically and cognitively structured presentations	real interests, personally meaningful tasks, high motivation
weaknesses	not necessarily relevant to the interests of the learner or the task at hand	coverage of the important concepts maybe missing demand driven, unstructured learning episodes
role of teacher	sage of the stage	guide on the side
meta-design perspective	design time: anticipating and planning of the learning goals and context, and content	learning needs arise of the situational context
distribution over lifetime	from elementary school → high school → university → lifelong learning: ***decreasing*** in its importance	from elementary school → high school → to university → lifelong learning: ***increasing*** in its importance
assessment	"standard" assessment instruments are applicable	"innovative" assessment instruments are needed
unique research challenges	presentation of an organized body of knowledge; user modeling; individual differences	task identification large repository of tutoring episodes

examples	Microsoft's Tip of the Day <A caricature of real tutoring?>	domain-oriented design environments, critiquing systems, contextualized explanations
requirements for new media	domain modeling, curricula (planning)	meta-design,

Self-Directed Learning and Curricula

- **Claim**: curriculum building is a process of sampling. We sometimes get so wound up thinking that there are things that have to be covered. There are a million things that have to be covered and there is no way that more than a hundred of them are going to be covered. So we might just as well recognize that we are sampling.

- **Curricula**: "basic skills" and "fundamental material" can be defined

- **self-directed learning:** learning is part of living → learners need not only instruction, but access to the world

- **question**: *when* does the sampling take places and *who* determines it?

New Forms of Learning Contributing to Lifelong Learning

Form	Comple-menting Form	Contribution toward Mindset Creation	Major Challenges	Media Requirements
self-directed learning	prescribed learning	authentic problems	problem framing	understanding evolving tasks
learning on demand	learning in advance	coverage is impossible; obsolescence is guaranteed	identifying breakdowns; integration of working and learning	critics; supporting reflection-in-action
informal learning	formal learning	learning by being in the world	larger, purposive activities provide learning opportunities	end-user modifiability
collaborative and organiza-tional learning	individual learning	the individual human mind is limited	shared understanding; exploiting the "symmetry of ignorance" as a source of power	externalizations understandable by all stakeholders

Working Hypotheses, Challenges (C) and Environments (E) Supporting Lifelong Learning

- the choice of tasks and goals must be under the control of the user/learner
  - **C:** creating systems that are simultaneously user-controlled and supportive
  - **E:** domain-oriented design environments

- new information must be relevant to "the task at hand"
  - **C:** saying the "right" thing at the "right" time in the "right" way
  - **E:** shared understanding, agents, information delivery

- "breakdowns" and "suggestions" must lead to opportunities for learning
  - **C:** artifacts do not speak for themselves
  - **E:** critics, simulation, argumentation, catalogs (case repositories), proactive learning

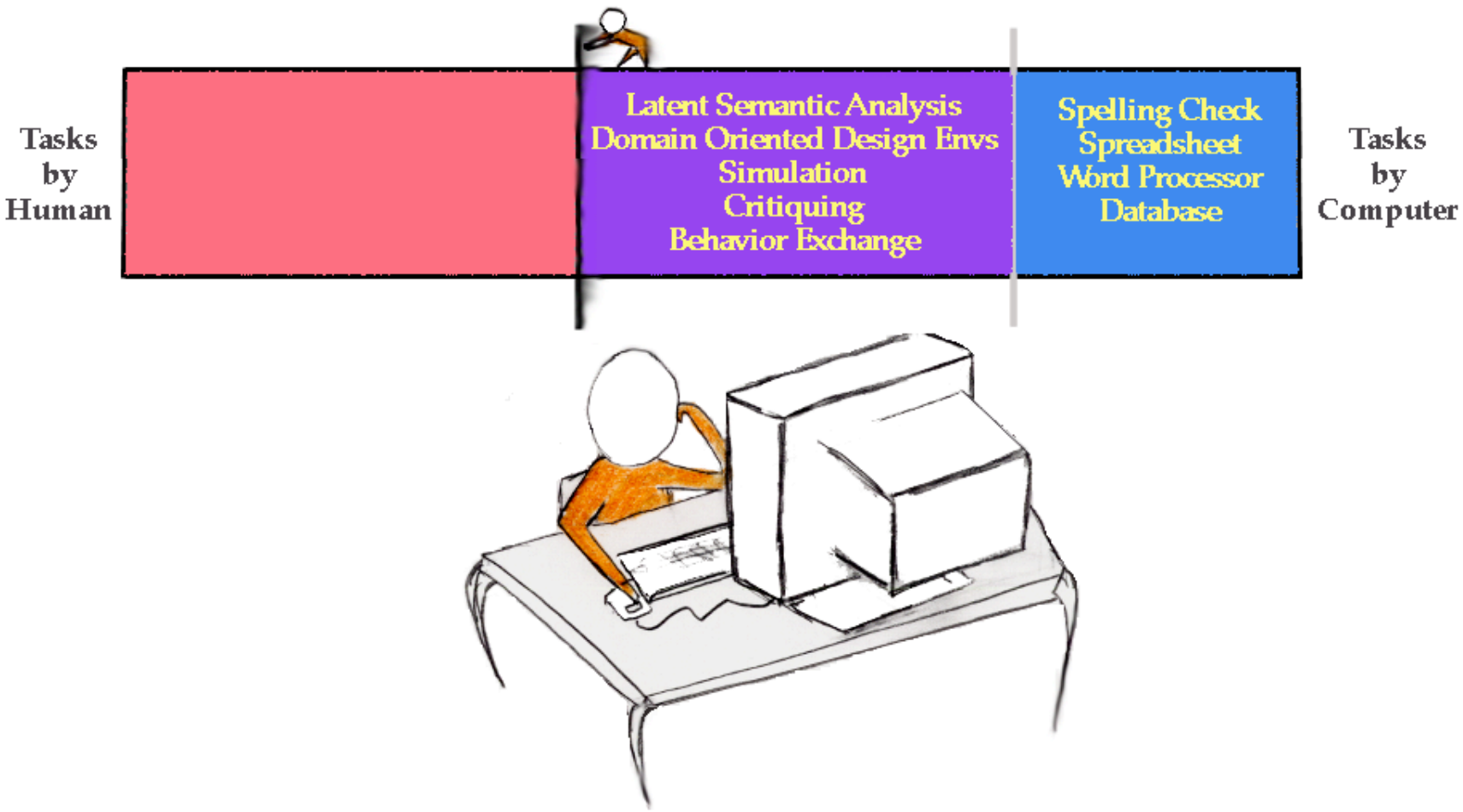
The Educational Theory we subscribe too

- self-determined, authentic problems → emphasis on constructionist approaches
- integration of working and learning (learning not as a separate activity)
- learner / teacher / expert are attributes of a context — not of a person; duality between LoD and EuM
- breakdowns as sources of creativity → create situations which talk back
- organizational learning / collaborative work practices / learning by community of practices

Space of Concepts we have developed over the years:

- low threshold / high ceiling
- increasingly complex micro-worlds
- active help systems / knowledge delivery / information volunteering
- high functionality applications (no experts any more, learning on demand, production paradox, suboptimal)
- critiquing
- design environments: making argumentation serve design,
- extracting context and intent
- process model: seeding, evolutionary growth, reseeding
- learning about the tool (e.g., LISP critic), learning about the domain (kitchen design, network design)

Using Innovative System Components to Allow Humans to Focus on Important Tasks



Assessment / Evaluation

- do critics enhance or hinder creativity (e.g., Fosbury Flop)? — Stravinsky: without constraints, there can be no creativity
- differences in performance, quality, and creativeness as a function of critics, catalog, simulation component?
- trade-offs between critiquing (breakdowns occur) versus constraint (breakdowns are prevented)
- trade-offs between different intervention strategies (active versus passive)
- does “making information relevant to the task at hand” prevent serendipity?
- under which conditions will designers challenge or extend the knowledge represented in the system?
- should the “back-talk” be embedded directly in the artifact or in a separate discourse?

Additional Thoughts — to Be Merged

- self-directed learners are active learners and generate substantial amounts of information: the fundamental problem which we want to address: resolving the inherent conflict between economics and education: the teachers' time and attention is a scarce resource — but educationally meaningful interactions require more of the teachers time and attention

- a constructionist approach towards education in which students can engage in self-directed, authentic learning activities requires substantially more teacher resources than the standard classroom lecture of today's university.

- steps towards the articulate learner (from player of Webquest to author and designer):
  - answer multiple choice questions
  - answer questions in an articulate way (→ LSA)
  - design your own game rather than playing someone else game
  - transcend text: develop simulations, artifacts as expressions of meaningful activities (--> DODEs, critiquing)
  - a truly articulate learner will become a teacher

assessment of background knowledge → in our approach this problem is more tractable, because the student is more articulate and therefore we have more information available to develop a context (including a student model)

something along the line: our envisioned environments supporting the articulate learner the role of the teacher will change: rather than being an oracle standing up in front of classes, the teacher will guide students, act as a consultant, give encouragement — and in order to do so, the learner needs to be much more articulate.

how would we address this potential criticism: if the answers of the students are processed by machines and not analyzed by the teacher — how can the teacher fill the role characterized in the previous paragraph?