Integrating Case Presentation with Simulation-Based Learning-by-Doing

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Abstract

In this paper we argue that the key to teaching someone to perform a complex task is to interleave instruction and practice in a way that exploits the synergism between the two effectively. Furthermore, we argue that computer simulations provide a particularly promising environment in which to achieve this interleaving. We will illustrate our argument by describing a simulation-based system we are building to train people to perform complex social tasks, such as selling consulting services. In particular, we will focus on the system's ability to present real-world cases at the moment that they are relevant to the student's simulated activities. In doing so, we hope to contribute both to the construction of useful teaching systems and to the theory of case-based reasoning, particularly in case retrieval.

Linking Practice and Instruction

In order to perform a complex skill effectively, a student needs to understand the abstract principles at work in the skill domain and must also learn how those principles apply in practice. When instruction and practice are combined appropriately, the student's actions in the practice environment are guided by instruction, and the abstract principles described by the instructor are motivated, operationalized, and made memorable by the student's experiences in the practice environment.

Computers can provide a vehicle for integrating instruction and practice through "Intelligent Learning-By-Doing Environments" (ILDE's). An ILDE provides two things for the user,

1. an interactive task environment, and
2. a suite of teaching modules.

The task environment puts the student into an active learning role, allowing the student to practice the target skill. The teaching modules monitor the student's interaction with the task environment. They treat the student as a traditional craftsman would treat an apprentice, providing coaching, modeling, and scaffolding for the student during the practice sessions. (See (Collins, Brown and Newman, 1989) and (Lave and Wenger, 1991).)

We are building several ILDE's, the largest and most sophisticated of which, GuSS-Sales (GUided Social Simulation-Sales)[2], is an ILDE we constructed to teach consultants how to sell consulting services. The program integrates simulated client interaction that actively engages the student with explicit discussion of real-world consulting cases and principles.

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[2]Some of the other ILDE's we are building teach geography through the task of taking car trips, social studies through broadcast journalism, and second languages through simulated conversations. They are described in (Kass and Guralnick, 1991) and (Ohmaye, 1992). The first incarnation of GuSS-Sales was called ESS (Engagement Simulation System). It is discussed in more detail in (Blevis and Kass, 1991) and (Kass and Blevis, 1991).

The social simulation architecture we have developed attempts to accomplish for a social environment what the flight simulator accomplishes for the physical environment of the cockpit. This architecture is particularly appropriate for teaching the complex interpersonal skills required in domains such as diplomacy, negotiation, and business. For instance, inexperienced business consultants need to learn the delicate skills required to successfully interact with client organizations. Such skills include

- discovering the official and unofficial structures of client organizations,
- dealing effectively with different personality types within those organizations, and extracting from people the information necessary to make recommendations, and
- making appropriate recommendations in a style that is convincing but not threatening.

The GuSS-Sales task environment includes many of the same obstacles and resources that a consultant would find in the real business world. Communication with other agents can be performed through face-to-face conversation, telephone calls, memos and written reports. Scanned in drawings and photos are used to show what the clients and their offices look like. The student can turn to charts, reports, higher-ups, and friendly coworkers for advice and assistance. Prospective clients, fellow consultants, and sellers from competing firms act on the basis of their own goals, beliefs, expectations, and attitudes. See (Kass and Blevis, 1991) and (Kass, et al., in prep.) for a detailed discussion of the design of the task environment.

The GuSS-Sales task environment attempts to provide the student consultant with an experience that is realistic, and is as memorable, in its own way, as the flight simulator experience for the aspiring pilot. The teaching modules in GuSS-Sales play a role analogous to that of an expert pilot watching over the actions of a student who is using a flight simulator. The modules can perform several different kinds of intervention. They can coax the student to try actions that might be useful, discuss an abstract concept currently at work in the simulation, or tell a relevant story that illuminates the current situation.

We are working on modules for each of these different types of intervention. In the remainder this paper, we will focus on the story-telling module, which is called SPIEL (Story-Producer for Interactive Environmental Learning). SPIEL monitors the simulation and presents cases from its library when they are relevant to the student's situation. We believe that case presentation (*i.e.* telling relevant stories) in the context of a simulation is a *particularly* useful way to link the experience with the simulation to general principles because stories describe principles *as they apply* in action. The following example illustrates the role played by SPIEL's stories in a typical session with GuSS-Sales.

GuSS-Sales and SPIEL in action

Each GuSS-Sales scenario begins with the student in his/her own office, where they can receive assignments in the same way a real consultant would. One representative scenario is as follows:

- The student gets a memo from her boss: there is a potential sales opportunity at a client that the boss is unable to follow up on.
- The student goes for an initial sales call and meets Bill Bell, the CEO of a department store chain.
- Bill expresses doubt about the value of consultants and asks for some concrete information about possible solutions to his problem. The student manages to allay his fears, side-step questions of detail and gather some needed information.
- At the end of the interview the student proposes that they begin by performing a "High Spot Review." (a standard procedure).
- Bill replies that a high spot review is a lot more than what he wanted.
- The student defends the review.
- Bill, unconvinced, becomes irritated, and begins to wonder whether consultants are worth the trouble.

This is a good time to give some feedback to the student. She knows that the High Spot Review is the best way to proceed, but she has lost sight on the fact that pleasing the client is more important that defending every detail of

the prospective job. One of the 171 stories currently stored in SPIEL's library of stories is relevant to this situation:

> **"Review Present Procedures"**
>
> You told Mr. Bell about your proposed approach. He disagreed. You continued to argue for your approach. Unfortunately, he is now angry with you. Here is a story about a similar situation in which the salesperson used a different method and was successful.
>
> We were working for a two-billion-dollar world-wide distribution company. We had sold the job and were presenting our work program, and when you present a work program, you have step one, step two, step three. Step one is always "Review present procedures," in [our] charts. Step two is a design or action step.
>
> So I was explaining this to the group using Japanese graphics on the board. I said the first thing we're going to do is review present procedures. [The senior managing director], said "No!" in Japanese. Of course, I asked him "Why not?" He said "We will decide what the future operation of the plant should look like, then we will use that vision, that new operation...we will use the system to enforce that operation." So I immediately took the transparencies and crossed off all the Japanese words and told the manager who was with me, the Japanese manager, to write down: "determine how to operate plant in the future." And he did that. Then we went on. Of course when we got on the job, part of the work to determine future operations was to review the present procedures.
>
> Your plan of arguing with the client didn't work well. In the future, you might consider agreeing when the client proposes an approach.

Paragraphs 2 and 3 above are verbatim presentations of a story from SPIEL's memory. SPIEL precedes each story with introductory paragraph called a **bridge** and summarizes each with a **coda** paragraph. The bridge explicitly connects the story context of the student's activity; the coda brings the student back to the events of the simulation by suggesting some possible actions. This example illustrates the synergistic interaction between the simulation and the explicit instruction and the simulation. Without the story provide an explanation for Bill's reaction, the student might be confused about how to interpret the events in the simulation. Without the active engagement provided by the simulation, however, the student might lack the motivation and context to read, understand and remember the story.

Storage and Retrieval

How does SPIEL manage to find relevant stories from its library to tell to the student? Tutorial storytelling is a case-retrieval task (Kolodner and Jona, 1991). Like case-based problem-solving systems, such as CHEF (Hammond, 1986), SPIEL must locate knowledge structures in its memory. CHEF indexed its recipes using features of the cooking goals that they could achieve. SPIEL's goal is to tell its stories in instructive ways. SPIEL's indexing system is therefore based on a theory of educational storytelling. This theory has three parts:

1. A representation language for expressing the indices attached to each story,
2. A theory of storytelling purposes,
3. A set of storytelling strategies which map an index and a storytelling purpose to a set of opportunity-recognition rules.

Since the stories must be recalled quickly as the student interacts with the task environment, SPIEL does as much preprocessing as possible at storage-time.

Storage Time:

1. Indices are attached to each story to be included in the database.
2. Each of SPIEL's 6 storytelling strategies examines each story index. If the strategy is applicable to the index, the strategy will generate an opportunity-recognition rule for that index, along with a bridge and coda template.
3. An optimized opportunity-recognition rule set is generated, which improves the speed of matching at retrieval time by eliminating redundant matching of identical clauses across the rule set.

Retrieval Time:

1. Opportunity-recognition rules are matched against the state of the simulation.
2. When a story is successfully retrieved, natural language text is generated that integrates the story into the student's current context.

Indices

A SPIEL index labels a story in terms of one of the points of the story. SPIEL labels each story in its library multiple times because a story can have multiple points. For instance, "Review present procedures" can be used to make a point about the need to match presentation content to the buyer's beliefs, the disparity between what the consultant says and what he does, the pitfalls of using standardized presentation materials, or the differences between Japanese business practices and those in America. A given story will have one SPIEL index attached to it for each point that the story can convey. Since SPIEL does not yet incorporate any natural-language understanding, the indices are generated manually.

The structure of SPIEL's indices is derived from the Universal Indexing Frame (Schank, et al. 1990). Since SPIEL is intended to teach planful activity, its indices center around plans, goals and expectations. Each index contrasts some component of the story as it actually occurred, with that component viewed from the perspective of a character in the story. There are five types of perspectives used in SPIEL's indices:

Expected: Some aspect of the story turns out differently that some character expected.

Perceived: There is a discrepancy between what some character perceived and what actually happens in the story.

Ideal: The actual events in the story vary from an ideal, usually that of the storyteller.

Feared: The story contrasts a character's fears with actual events in the story.

Wanted: The story contrasts a character's desires against the actual events in the story.

The interpretation of "Review present procedures" that gets activated in the example focuses on the salesperson's method for dealing with the client's objection. Since the consulting firm puts great store by their problem-solving methodology, a consultant should, ideally, be able to defend that methodology when it is challenged. In this story, the consultant does not defend the firm's methodology.

Perspective type: Ideal

Ideal component: Consultant employs defend-methodology plan to achieve sell-work goal.

Actual component: Consultant employs agree-with-client plan to achieve sell-work goal.

Story-Telling Strategies

For any given index SPIEL may have several applicable story-telling strategies. A story-telling strategy represents the class of situations in which a story of a particular type is likely to be worth telling. For instance, the story-telling strategy that brought up the above example is as follows:

Strategy 1: Demonstrate alternative plan: Tell a story about a successful plan to achieve a particular goal when the student has executed a different plan and failed to achieve the goal.

The same story can also be used to *explain* the actions of someone in the simulation whose actions might otherwise be mysterious. For instance, suppose the student were collaborating with a more senior consultant on a presentation. If the other consultant knew that a normal step in the process was objectionable to the client he might omit that step from the presentation. The student would probably be confused be confused by this, but. The "Review present procedures" story can explain the partner's actions, and help the student generalize this experience. The SPIEL strategy responsible for bringing the story up in this situation is as follows:

Strategy 2: Explain other's plan: Tell about a successful plan that the student may not know about when someone has just executed a similar plan.

SPIEL has a total of six storytelling strategies. The remaining four are as follows:

Strategy 3: Reinforce plan: Tell a story about a successful plan to achieve a particular goal when the student has just executed a similar plan.

Strategy 4: Warn about plan: Tell a story about an unsuccessful plan when the student has begun executing a similar plan.

Strategy 5: Demonstrate alternative result: Tell a story about the result of a particular course of action when the student has just executed a similar course of action but experienced different results. (similar to 3 and 4 above, except that the contrast need not involve success and failure).

Strategy 6: Warn about perspective: Tell a story about someone's unrealized expectation (or perception, fear, ideal, or desire), when a student appears to have that same expectation.

These strategies correspond to goals a tutor would have when trying to teach someone how to plan and engage in an activity. **Explain other's plan** in particular applies only to a social domain, in which there are other individuals whose plans may need to be explained. When the tutor's goal is not to teach how to plan a course of action, but to teach something else, such as design, the same basic storage and retrieval algorithm would apply, but different indices and different storytelling strategies would be required.

CreANIMate (Edelson, 1991), for example, tells stories about animals in the course of a tutorial dialog centered around a design task: putting together an imaginary animal. CreANIMate's stories are about animals, not about students who have tried to design animals, so its stories relate to the product of the student's design activity, not the design activity itself. An analogous task in the selling domain might be looking at a contract the student has negotiated and retrieving stories about other contracts, based purely on the features of the document itself. Additional storytelling strategies would be needed for SPIEL to tell stories in this mode.

SPIEL uses its storytelling strategies at storage-time to precompute a set of all situations in which a given story would be relevant as well as to precompute the template used to produce the bridge and coda.

SPIEL's strategies have three parts:

- **Applicability test:** The applicability test determines whether the index is appropriate for this strategy.

  Example: Strategy 1 is obviously only applicable to stories making a point about successful plans. Its applicability test involves checking the ACTUAL-RESULT slot of the index to see if it contains a successful outcome.

- **Recognition-condition generator:** The recognition-condition generator uses the index and the system's domain knowledge to generate specific opportunity-recognition conditions for the index.

  Example: Strategy 1 prepares SPIEL to tell "Review present procedures" in situations where the student is pursuing a goal similar to please-the-client, but is pursuing a plan that is *not* similar to agree-with-client-about-procedure. The result is an opportunity-recognition rule that looks like this:

TELL "Review present procedures" AS A
Demonstrate-alternative-plan story WHEN
the student has been talking to a client whose opinion affects a sale.
AND the student told the client about a proposed method or approach.
AND the client reacted negatively or present an alternative.
AND the student argued for the proposal and/or against alternative.
AND the client reacted negatively to the student's action.

- **Natural language templates:** The natural language templates are used at retrieval time to generate explanations for the student, indicating why the retriever believes that the story may be relevant. Each storytelling strategy employs a different set of bridge and coda templates.

Conclusion

We believe that our work on GuSS-Sales represents a contribution on two fronts: to the practical technology of education and training, and to the important theoretical problem of case retrieval. The GuSS architecture consists of an interactive task environment and a suite of expert teaching modules that run concurrently. That combination is educationally powerful because instruction and practice are interleaved, each complimenting the other. The overall result is therefore much stronger than either practice or instruction alone. Since the teaching modules are able to monitor and interrupt student's practice activities, they can deliver their instructional messages in the

most timely possible fashion. The system is thus able to help the student combine information sources. The teaching modules can help the student generalize the lesson of a concrete experience, and the practice environment can help the student experience the principles that the teaching modules describe.

Stories about real-world cases provide a form of instruction that is particularly well-suited to teaching complex skills in the context of a simulation. They allow the student to tie principles to action, and they bridge the gap between the student's experiences within the simulation and the broader set of real-world challenges they will face. The main question we have addressed in designing SPIEL is how a system can notice when it has a story that is relevant. This requires two theories. The first is a theory of how a story can be represented in a way that is useful for retrieval. This theory is implemented in SPIEL's indexing scheme. The second is a theory of the set of purposes that telling a story can serve. This is the theory behind SPIEL's storytelling strategies. By combining an index for a particular story with a story-telling strategy, SPIEL can determine when and how to tell each of its stories.

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