PROPOSAL FOR SEARLE FACULTY WORKSHOP

Indie: Building Web-based Interactive Learning Environments to Facilitate Delivering Problem-based Learning

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Introduction

Problem-based learning centers learning activities around the investigation and development of solutions to complex realistic problems. However, working on realistic problems can be expensive and even dangerous for students, and supporting such projects is very labor-intensive for the faculty. Computer-based interactive learning environments provide responsive and safe settings for doing realistic problem-based learning activities, but such systems are expensive and complicated to build or customize. To address these problems, we have built Indie, a content-independent tool for authoring and delivering web-based interactive learning environments where students can practice solving problems by running experiments and using the results to support or refute possible hypotheses. This workshop will demonstrate how Indie can be used to facilitate problem-based learning and benefit both the students and faculty member.

System Description

An Indie learning environment consists of a set of web interfaces: a welcoming screen showing the "challenge" document, a "reference" interface where students can browse materials describing the scenario and domain content, an "experiment" interface where students can order tests and collect results, a "feedback" interface where students can read and respond to comments from the instructor on their activities, and a "report" interface where students can construct arguments for or against possible hypotheses. Indie learning environments automatically generate lab test results based on requests from students and provide scaffolding for students to construct arguments.

As a concrete example of an Indie learning environment, we will describe Corrosion Investigator, a module on biofilms. In this example, environmental engineering students take the role of consultants helping a paper processing company find the cause and cure for recurring pipe corrosion. Indie itself is a generic framework. All of the subject-specific material (text, pictures, the tests students can run, the results they get, and so on) is added using the Indie authoring tool.

For other areas where the Indie approach has been used, go to: <u>http://www.cs.northwestern.edu/~riesbeck/indie/projects.html</u> This shows systems built with an earlier non-web Macintosh-only version of Indie.

An Example: Corrosion Investigator

When students first enter the learning environment, a challenge page explains the problem context to the students. Students can then go to the Reference screen to read background documents (Fig. 1).



Figure 1: The Reference screen in Corrosion Investigator.

To run tests, students go to the Experiment screen (Fig. 2). Here, students can look for tests by entering test names into a textbox. Tests matching the name will be shown. Students can view the description of the tests and possible variable values for the tests.

Corrosion Investigator	Project Cost: \$95050 Day 36 Advance Date
lotebook	Test
check point 1 flow rate: 5.015 m/s check point 1 flow rate: 5.654 m/s check point 11 flow rate: 3.83 m/s	Community analysis Look for test
check point 12 flow rate: 3369 m/s check point 10 wrate: 1365 m/s check point 16 m/ste: 16545 m/s check point 3 flow rate: 16545 m/s check point 4 flow rate: 1665 m/s check point 5 flow rate: 16216 m/s check point 5 flow rate: 16275 m/s	DGGE analysis DGGE (denaturing gradient gel electrophoresis) allows the use of comparative DNA analysis to determine the number of species present in a given sample. The premise of the test is that nucleic oxid is extracted from environmental samples and is
Results	subjected to amplification with the polymerase chain reaction (PCR). After PCR, the DNA fragments generated from the reaction are run on a denaturng polyacrylamide gel. Each band present on this gel corresponds to a unique sequence of DNA, which in turn corresponds to a distinct bacterial species. Depending upon the primer set chosen for PCR, one can look at
DGGE RESULTS: Location of Sample: check point 8	the number of species present for different metabolic types of bacteria.
all bacteria: 289 bands	Provider: Abbott laboratories, Inc.

Figure 2: The Experiment screen in Corrosion Investigator.

When the test results become available, they appear in both the Notebook and Results area (see Fig. 2). The Notebook records all the test results that the student has received in a list that can be used for constructing a report.

Corrosion Investigator	Experiment Report Feedback Reference Logout
	Project Cost: \$115600 Day 77 Advence Date
Source	Comments
DOWNSTREAM PIPES: Acidic pH and chemical oxidati pipes the main cause of corrosion in the downstream pipes. level is acidic enough to cause corrosion. Although SRB's a present in relatively high numbers, we feel that they are pres to periodic flushing of the downstream pipes which dislodge of the biofilm population.	pH occurring in the downstream pipes. More re still detail could be supplied in regards to the nature of the corrosion. What type of
[Water Chemistry check point 9]pH: 4.243 Reason: Acidic pH suggest that process may be more chemi- controlled compared to recirculating pipes.	cally respond
[Water Chemistry check point 9]SO4: 83.08 mg/L Reason: High sulfate is still present, indicating SRB's may b active.	respond
[Water Chemistry check point 9]H2S: 32.546 mg/L Reason: Not as high as in recirculating pipes. Corrosions m combination of bio and chemical processes.	Not well explained- is H2S derived from activity at that location, or is it left over from water derived from flushed recirculating water respond

Figure 3: The Feedback screen in Corrosion Investigator.

On the Feedback screen (Fig. 3), students can read and respond to comments from their supervisor on their work.

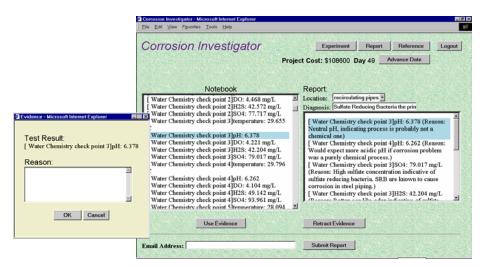


Figure 4: The Report screen in Corrosion Investigator.

When students feel they have gathered enough information, they can go to the Report screen (Fig. 4), make claims, and apply evidence in the Notebook towards those claims. Students need to specify the reason for using a test result as evidence. After finishing constructing the report, students click the Submit button to submit their report.

Authoring Tool

The Indie authoring tool provides a form-based web interface (Fig. 5) that allows teachers to describe the content of an Indie learning environment, e.g., a scenario challenge, the tests students can run, test result generation methods, background information, and so on, with no programming.

	Edit FISH	Test		Tools: <u>view domai</u>	n view scenario run checker	run indie
lit IselieModel > Edit biofilm Domain > Edit R	13H Teit					
abel FISH		choose	*	fixed cost(\$) (The fixed amount of money that it 0.0		
FISH		[choose	<u> </u>	10.0	choose	<u> </u>
delay(days) (The fixed number of	days that this test alw			isInt (Are test results always integers?)		
35		choose	*	True		-
description file						
fish.html		choose	*			
Add	Delete					
Add Edit I	Delete					
eywords:	Delete					
regwords: probe fish 16SrRNA 16S rRNA	Delete					
wywords: probe fish 16SrRNA 16SrRNA 15SrRNA T-RFLP species composition	Delete					
sywords: probe fish 16SrRNA 16SrRNA T-RFLP species composition community analysis						
sywords: probe fish 16SrRNA 16SrRNA 15SrRNA species composition community analysis	Delete					
sywords: probe fish 16SrRNA 16SrRNA T-RFLP species composition community analysis						

Figure 5: The Indie authoring tool.

Results of Previous Usage

In May of 2002, Corrosion Investigator was used in an Environmental Microbiology class by six first-year graduate students in the Civil Engineering Department. They were asked to form into two groups of three each. Students completed a survey on their experience at the end.

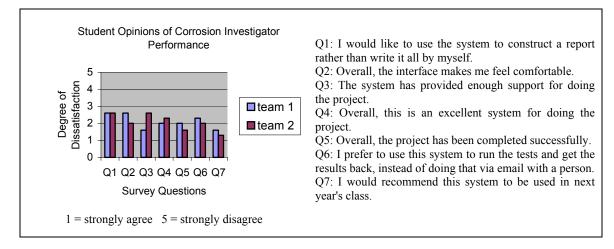


Figure 6: Student opinions of Corrosion Investigator performance

According to the students' responses shown in Figure 6, overall the system was satisfying for doing the project. According to the professor, the use of the Corrosion Investigator significantly reduced his workload from 24 man-hours to 4 man-hours. By using the software, the project time was reduced from 8 weeks (the time it took when the same scenario was delivered without the software) to 3 weeks. According to the professor, the quality of the students' final reports using the Corrosion Investigator was identical in quality to those of the students when he taught the course without the software. Though the data was based on only six participants, it is still encouraging.

The professor used the tool to enter the following fairly complex test (see Fig. 7) into the learning environment, including keywords that the system uses to match student test inquiry, parameters for the test, parameter values that students can pick, result ranges associated with parameter value combination, etc. This process took about two hours.

 keywords: species co 	mposition; T- 1 00 per primer s	mmunity structu RFLP; 16sRNA;	ure; community a 16s rRNA; prob	
primer set / location of sample	Checkpoint 1	Checkpoint 2, Checkpoint 3, Checkpoint 4, Checkpoint 5, Checkpoint 6, Checkpoint 7, Checkpoint 8	Checkpoint 9, Checkpoint 10	Checkpoint 11, Checkpoint 12
all bacteria	1500 - 4000	5000 - 10000	2500 - 6000	5 - 50
methanogens	50 - 500	250 -	1 - 50	

Figure 7: Description of the FISH test.

Deployment and Access

Students and faculty can run Indie learning environments using Internet Explorer 5.5 or above on either a Windows or a Mac computer. The authoring tool is similarly web-based. No special software needs to be installed on the users' computers to use Indie.

We are ready and eager to work with faculty members to create other Indie learning environments in different domains, and to help collect data to assess student learning outcomes. Indie is appropriate in any area where gathering data via tests or some kind, and using that data to construct arguments, is a valid activity. While Corrosion Investigator demonstrates a particular complicated example of Indie systems, your module does not need to have the same complexity. We will provide you with design and implementation support throughout developmental process.

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