

Data Sharing Among Intelligent Teaching Systems

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Over the last four decades, researchers around the world have developed a wide variety of intelligent tutoring systems, personal learning assistants, and adaptive practice environments. Although clearly effective in trials, very few of those systems have found their way out of the lab into commercial use. One major reason for their sluggish adoption is that these systems have been designed as stand-alone monoliths, building an internal “student model” as the learner progresses through the material. They neither request information from other systems, nor share what they have learned about the learner with other systems. In the research environment, communication with the software applications used by students, teachers, and administrators has not been a design requirement.

Educational software is rapidly moving into the Internet era: on the web, new functionality is built on top of data stored in other systems. The non-profit LETSI Foundation (Learning, Education, and Training Systems Interoperability) is focused on accelerating the adoption and evolution of innovative teaching and learning systems by lowering the barriers to market entry. In the early stages of a new technology, data interoperability is key to the early adopters’ successful deployment, which in turn spurs additional investment, resulting in continued innovation. LETSI applies modern, collaborative software design methodology to address the need for new products and services to exchange meaningful information.

Background and Rationale

The project we propose is an open requirements-gathering and prototyping effort to advance communications among elearning systems that know more than just the learner’s name and test scores. We will enlist participants from a broad spectrum of stakeholders to work out the requirements for communication among advanced learning systems that are intelligent, adaptive, and personalized:

- Personal assistants for learners (PALs) will manage assignments, keep records, and send reminders. As these products get more intelligent, they will recommend activities the learner might be interested in or might need for remediation or certification. One could imagine Facebook or Apple offering learners their own PAL.
- Learning monitor apps will help teachers, private tutors, and parents track students’ progress and understand how to help. These apps will record the learner’s activity and grades and, as the software becomes more intelligent, help a teacher understand what’s actually going on in her students’ online activities. These systems

must be informed about not only the student's status and scores, but also about his misunderstandings, confusions, special interests, creative productions, and so on.

- Institutional learning management systems (LMS) and learning record stores (LRS) will maintain the role that the LMSs has now – managing learners and their history. Teachers and students may be associated with many different institutions over time.
- Publishers' and other education content providers' websites will accumulate learner data across multiple courses and activities, possibly through many years of schooling. Elearning vendors, old and new, will add intelligent features to differentiate their online offerings.
- Learning record stores, established by educational institutions, school districts, tutoring companies, researchers, and others, will have their own reasons for storing learner data. Each institution and jurisdiction will restrict access to safeguard the privacy of the learners' personal data. Nevertheless, the information they hold is a key piece of the picture that, if securely shared with intelligent applications, could dramatically improve their effectiveness.

In today's elearning ecosystem, the institutional learning management system controls the learner's entire experience and stores all learning-related data. In SCORM and similar runtime data frameworks, very little of this data about his prior work is made available to the student's next learning activity – personalization often amounts only to knowing the student's name. Project Tin Can will make it possible for any system to send progress and performance data to any learning record store. In this model, though, the LRS is still a data silo. We are aware of no proposed framework for the higher-level, two-way information flow required to support intelligent systems – systems that develop sufficient understanding about the learner to make decisions, observations, and recommendations.

Project Goal

Defining a data exchange framework that allows intelligent systems to enhance each other by sharing actionable data about learners and learning will open a floodgate for innovative apps and web-based services for teachers and learners. Our project's goal is to find solutions to key early-stage interoperability issues in intelligent teaching systems. Initially, these questions top our list:

1. **Who will be communicating with whom?** What is the structure of the learning ecosystem and who are the actors? How can we enable secure communication in a complex, non-LMS-based learning environment? LETSI believes that a role-based communications framework, like those developed for intelligent agents and robotics, is needed if we are to enable secure data exchange without hardwiring into the solution inappropriate assumptions about future pedagogy, institutions, products, and business models.
2. **What will this new array of intelligent systems want to communicate about?** What kinds of information would be helpful to a teacher or personal learning assistant or to a subsequent learning activity, including persistent characteristics of the learner;

factors that will shape a learner's personalized path through the material; and assessments that indicate mastery level or misunderstandings in a given lesson. Defining this protocol is not only a technical task – teachers and researchers must be involved in this requirements-gathering process.

3. **How can we facilitate product introduction across different communities of practice?** To succeed, innovative product and service vendors must accommodate wide variations across firms, educational institutions, and political jurisdictions. For example, LETSI has proposed a Data Model Definition framework (DMD) that might be used to establish an extensible structure and baseline vocabulary for defining data payloads, perhaps building on the Tin Can 1.0 verbs. The DMD includes an extension mechanism that supports variation across communities of practice as well as the introduction of new data elements, e.g., by yet-to-be-invented elearning products.
4. **What kind of interoperability solution is appropriate?** There are many kinds of interoperability solutions. Whether the market needs an ISO standard, or a set of software tools, or a centrally maintained ontology, for example, is a business question as well as a technical one. Will the elearning community support an interoperability solution based on shared ontologies? Are new infrastructure elements needed, e.g., for identity management, competency definition, access control, students' records, and so on? What kind of product conformance testing regime might be required?
5. **How can innovative software companies comply with the privacy regulations that protect students' data?** The more data we share, the more intelligent our systems will appear. In the education market, however, developers are faced with highly divergent security and privacy regimes across institutions, communities of practice, and political jurisdictions. This potentially serious barrier to adoption of innovative products is especially problematic for small startup companies with limited development resources.

If we are successful, we will have reached consensus on an approach to the key interoperability issues. In areas where there is industry demand for a working solution, this project will spin off ongoing, open software implementation teams, laying the groundwork for the entire community's adoption of a new breed of intelligent teaching systems.

Approach and Timeline

We believe that an open process involving product developers, teachers, and researchers is the best approach to developing a viable communications framework for intelligent teaching and learning systems. We are proposing a one-year project with the following overall plan, by quarters:

- 1stQ Working with the ADL and initial project participants, we will refine the above list of key issues in high-level communication among intelligent systems. We expect that working groups will form around these topics, but, of course, we will remain flexible as the discussion evolves.

We will then prepare and distribute a solicitation of white papers that present specific use cases or propose approaches or solutions.

2ndQ A wiki-based discussion forum will be established where each submitted white paper will be posted and where participants can comment and start discussion threads.

A knowledgeable working group leader will be retained in each topic area. The topic leaders will read all the white papers, facilitate online discussion of the issues as the papers are submitted, and convene periodic online working meetings as appropriate. The topic leaders will also plan the breakout sessions for the Workshop.

3rdQ A face-to-face Workshop (largely participant-funded) will be convened to give working group participants a chance to iron out differences and finalize their implementation decisions.

4thQ In those topic areas where we achieve consensus about the requirements for an interoperability solution and where there is adequate industry demand and developer participation, we will launch a follow-on implementation and testing project. It is possible that not all of the working groups will result in separate implementation projects.

The topic leaders will collaborate on a final report describing the Workshop conclusions and the direction of the implementation working groups.

The implementation teams will continue for 6-18 months or even longer. Their ongoing work will be staffed and funded by stakeholder organizations. We believe that this open, collaborative, government-industry approach, and unconstrained sharing of the resulting intellectual property, is the best way to support innovators and push learning technology forward.

This project plan reflects many of the best processes that LETSI used in an earlier, successful project where we collected requirements for SCORM 2.0. Funded by government and industry participants, LETSI got an enthusiastic response to its original solicitation of input to the process – over 100 white papers from teachers, technologists, and researchers. The white papers were posted publicly and generated dozens of online discussion threads over several months, which culminated in a face-to-face meeting in Pensacola.

The resulting report (the SCORM 2.0 Assumptions Document) presented a well-articulated set of issues and proposed solutions. Finally, LETSI organized a dozen implementers from industry and government, again funded by participating organizations, to build, test, and demonstrate a working solution at I/ITSEC: the Run-Time Web Services specification is a modernization of the run time communications in SCORM. This technical work allowed

communication between stand-alone learning activities (simulations, games, ITSs) and the central learning management system. It has been directly incorporated into the ADL's Tin Can Project.

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