# What is the Open Knowledge Initiative™?

September 20th, 2002

The Open Knowledge Initiative™ (O.K.I.) is defining an open and extensible architecture for learning technology specifically targeted to the needs of the higher education community. O.K.I. provides detailed specifications for interfaces among components of a learning management environment, and open source examples of how these interfaces work. The O.K.I. architecture is intended to be used both by commercial product vendors and by higher education product developers. It provides a stable, scalable base that supports the flexibility needed by higher education as learning technology is increasingly integrated into the education process.



* A white paper prepared by Eduworks Corporation for O.K.I.™

# Abstract

The Open Knowledge Initiative (O.K.I.) is defining an architecture that precisely specifies how the components of a learning technology environment communicate with each other and with other campus systems. By clearly defining points of interoperability, the architecture allows the components of a complex learning environment to be developed and updated independently of each other. This leads to a number of important benefits:

- Learning technologies appropriate for **a range of teaching and learning requirements** can be integrated together into a common environment. The needs of the Math department are not those of the English department, and tools that work well for new users may not be adequate for seasoned users.
- Learning technology and content can be more **easily shared among schools and departments**. This provides a catalyst for cooperative and commercial development.
- There is a **lower long term cost of software ownership** because single components can be replaced or upgraded without requiring all other components to be modified.
- Modularity makes learning technology **more stable, more reliable, and able to grow with increased usage,** and allows components to be updated without destabilizing other parts of the environment. O.K.I. is based on technologies that have proven to be scalable and dependable in large scale enterprise computing environments
- The architecture offers a **standardized basis for learning technology software development**. This reduces development effort and encourages the development of specialized components that integrate into larger systems.

At the core of O.K.I. is a set of application programming interfaces (APIs) that realize the O.K.I. architecture. O.K.I. is providing Java versions of these APIs. These Java APIs are provided for use in Java-based systems and also as models for other object-oriented and service-based implementations. O.K.I.'s partners and developer community are providing open source examples and reference implementations of learning technologies that make use of the APIs.

Higher education leaders recognize that learning environments are a core component of their information technology infrastructure. These environments must successfully support faculty and students, and they must be flexible enough to adapt to a range of instructional requirements and styles. The technologies must be robust and must scale up to support an ever-increasing demand.

O.K.I. is being developed by and for higher education. O.K.I. was started with Mellon Foundation funding and has grown as partners have received additional funding for specific O.K.I.-related projects and activities. Institutions of higher education can take concrete steps to move O.K.I. forward. These include making O.K.I. part of procurement and product definition cycles and participating in the O.K.I. development community. This will help direct the efforts of the vendor community and will help campuses move more quickly to a stable and scalable learning technology infrastructure that effectively supports their educational processes.

# Executive Summary

The use of the web and other technology to support teaching and learning is rapidly becoming a pervasive reality. The 2001 Campus Computing Survey reports that almost three fourths of all participating U.S. institutions had established a product as their "standard" campus course management system and that almost one-fifth of classes were supported to some degree by such a system.[1]

Higher education leaders recognize that learning environments are now a core component of their information technology infrastructure. These technologies must be robust, and they must successfully scale up to support an ever-increasing workload. They must adapt to new technologies over time, and they must integrate with the existing campus infrastructure. Most importantly, learning environments must successfully support faculty and students. They must be enabling technologies, flexible enough to adapt to a wide range of instructional requirements and styles yet stable enough to allow faculty and students to concentrate on teaching and learning and not on the technology itself.

### O.K.I. is an Architecture

The Open Knowledge Initiative (O.K.I.) provides an open, extensible and clearly defined architecture that helps learning environments meet these demands. The interface methods defined by O.K.I. support the ongoing integration of three general categories of software:

- Learning applications ranging from individual quizzing, authoring, and collaboration tools to suites of such tools that include course management and learning management capabilities,
- Central administrative systems such as student information, human resource, and directory management, and
- Academic systems including library information systems and digital repositories of research and educational materials.

Once this architecture is fully adopted by the education market, new components may be plugged into the learning infrastructure using O.K.I.'s tightly defined and standardized application programming interfaces (APIs). This will allow schools to more easily take advantage of new technology and new learning management components as they become available. It will also allow components to be updated individually without destabilizing the overall environment.

Although O.K.I. may not reduce the initial cost and effort of setting up a comprehensive learning technology system, O.K.I. is intended to reduce the ongoing cost of maintaining and updating such a system. O.K.I. will provide stability, durability, flexibility and scalability, all of which are required to reap the maximum benefit from an investment in learning technology.

### O.K.I. Enables the Sharing of Solutions

The O.K.I. architecture enables the sharing of learning content and software applications among schools and departments. The common architecture and common interfaces will allow schools to more easily implement components developed by other organizations, as long as all parties are

[1] 2001 Campus Computing Survey, see http://www.campuscomputing.net/pdf/2001-CCP.pdf.

conforming to the architecture. To demonstrate this, O.K.I. will make the MIT, Stanford University and University of Michigan learning management environments available as open source code to whoever wants to use them, including commercial vendors. However, it is important to understand that this software is not productized, nor is O.K.I. a "free software" initiative. The open source systems provided by O.K.I. do not come with training, support, a bug fix process, a help desk, implementation guidelines and services, or ongoing upgrades.

### O.K.I. is Specifically Designed for the Needs of Higher Education

O.K.I. is a practical initiative driven by the need to support faculty who are trying to do more sophisticated and creative things with online education and who have become increasingly frustrated with available tools and products. O.K.I. is designed by and for higher education. O.K.I. has value for all types of learning environments, but first and foremost it focuses on the needs for true interoperability and an open layered architecture in an educational environment. It is specifically designed to support evolving and flexible teaching and learning requirements.

O.K.I. is also targeted towards software vendors and system integrators working for Higher Education institutions. O.K.I. provides an environment that enables them to develop more modular solutions. The ability to plug solutions into any learning system should encourage the development of commercial solutions that target the specialized needs of different institutions and areas of study. Flexibility, stability and componentization are the ultimate goals of O.K.I., and its success will be measured in part by the movement of vendors away from "one size fits all" products to commercially viable solutions that meet the diverse needs of higher education.

### O.K.I. is Part of a Global Standards Movement

At the same time, O.K.I. is part of a global learning technology standards movement that applies to all education, learning, and training sectors. Organizations around the world are working to create specifications that support interoperability among learning systems and that enable the widespread exchange and distribution of learning content. The standards organization best known in U.S. higher education is the IMS Global Learning Consortium, followed perhaps by the Advanced Distributed Learning initiative (producers of the Shareable Content Object Reference Model, or SCORM) and the IEEE Learning Technology Standards Committee.

Wherever appropriate, O.K.I. is making use of the standards and specifications developed by these organizations. O.K.I. is also actively influencing the development of these global standards by communicating the requirements of higher education, and ensuring that these needs are addressed in the work of the larger learning technology standards community.

### The Status of O.K.I.

O.K.I. has already released definitions of a number of the APIs used to support common services such as authentication and authorization. The O.K.I. team is continuing work on infrastructure APIs, and is also moving ahead with defining APIs for Class Administration and Content Repository services. These will be released during the second half of 2002. There are open source components publicly available on the O.K.I. Web site and others will be released as they become available. MIT, Stanford University and the University of Michigan have begun adapting several of the O.K.I. common service APIs to their learning management systems.

The Mellon Foundation has provided initial funding to support the core project through the middle of 2003. MIT and partner institutions[2] are supporting the initiative internally, and are also obtaining additional funding from the Mellon Foundation and other sources for implementation projects and product development initiatives.

It is hoped that higher education leaders will recognize the value of O.K.I. in supporting a rich and effective approach to online learning. Institutions and software vendors who intend to support O.K.I. can help by stepping forward and declaring their support in announcements as well as by incorporating O.K.I. conformance into purchase requirements and development plans. Even though O.K.I. is very much a "behind the scenes" technology, it deserves to be front and center in the decisions being made today that will shape our educational environments tomorrow.

[2] The Massachusetts Institute of Technology leads the project in close collaboration with a growing community of partners, including Dartmouth College, Indiana University Bloomington, North Carolina State University, Stanford University, University of Cambridge, University of Michigan, University of Pennsylvania, and University of Wisconsin-Madison.

# 1 The Challenge

Course management systems are now commonplace in higher education and faculty are becoming more sophisticated about the use of educational technology in teaching. Products like WebCT™, Blackboard™ and eCollege™ provide comprehensive and integrated tool sets, but were designed for ease of use and not to meet the needs of more sophisticated users. Something more is required.

Even ignoring instructional effectiveness, most academic products on the market today were initially conceived as solutions for departments, or even single courses. Their underlying architectures did not anticipate the need to scale to many thousands of students and to smoothly integrate with student information, financial, human resources, and other academic computing systems. The price of the course management systems themselves is rising as vendors strive for profitability, and anecdotal evidence indicates that some campuses have written more lines of code to integrate their campus systems with a vendor's course management system than there are lines of code in the vendor's system itself. Massive customized in-house development brings with it not only cost but also an increased risk of a system failure that cannot be diagnosed or that cannot be fixed at a reasonable cost.

Finally, there is a need for the technology being used to deliver online higher education courses to conform to international learning technology standards. The standards in question are designed to promote interoperability among learning content and online learning systems and are gaining acceptance worldwide. Whereas there are reasons for higher education to want to be isolated from the main stream in many areas, in this case the isolation can only serve to drive up costs and restrict choice.

This situation is not tolerable. Higher education leaders must find a way to reduce the cost and complexity of system integration work while ensuring that their learning systems are built on a reliable and scalable architecture that allows them the flexibility to meet the needs of diverse teaching and learning styles. The educational technology systems of the future must be built from the perspective of enterprise infrastructure. They must be based on an open and modular framework that can be used by software vendors and that meets the needs of entire campuses, individual departments, and even single courses. And they must be based on international standards that are being used by formal educational systems around the world.

# 2 The Open Knowledge Initiative

## 2.1 Mission

To meet this challenge, O.K.I. was started in January of 2001 with Mellon Foundation funding. Its mission is to provide a framework, or architecture, for higher education learning systems. The Massachusetts Institute of Technology leads the project in close collaboration with a growing community of partners, including Stanford University, the University of Michigan, the University of Cambridge, Dartmouth College, North Carolina State University, the University of Pennsylvania, and the University of Wisconsin-Madison.

## 2.2 Deliverables

O.K.I. has settled on two basic deliverables:

1. A set of APIs, described abstractly and written in Java, that enable educational technology to provide and access commonly used services. These APIs are freely available, and are supported by reference examples of working learning platforms and documentation of the architectural assumptions underlying the APIs.

2. Components of learning management software developed by MIT (Stellar), by Stanford University (Course Work) and by the University of Michigan (Chef). This code will be made available as open source code that can be freely incorporated into learning system components built by universities or by commercial software vendors.

These deliverables give substance to the architecture. O.K.I. hopes they will also act as the basis for the development of a community where both open source and commercially licensed tools and products can evolve.

## 2.3 O.K.I. Architecture and APIs

At the core of O.K.I. is an architectural view of a campus or enterprise educational computing environment. This view starts with an *institutional infrastructure layer* that includes "back end" capabilities like file systems, databases, registries, and authentication servers. All applications that fit into an institutional computing environment make use of the institutional infrastructure. One of O.K.I.'s goals is to allow educational applications and the institutional infrastructure to be developed and maintained independently of each other. This modularity provides longevity in the face of changes in devices, operating systems, and communication protocols. It also allows emerging technology and local innovations to be more quickly and easily developed and incorporated.

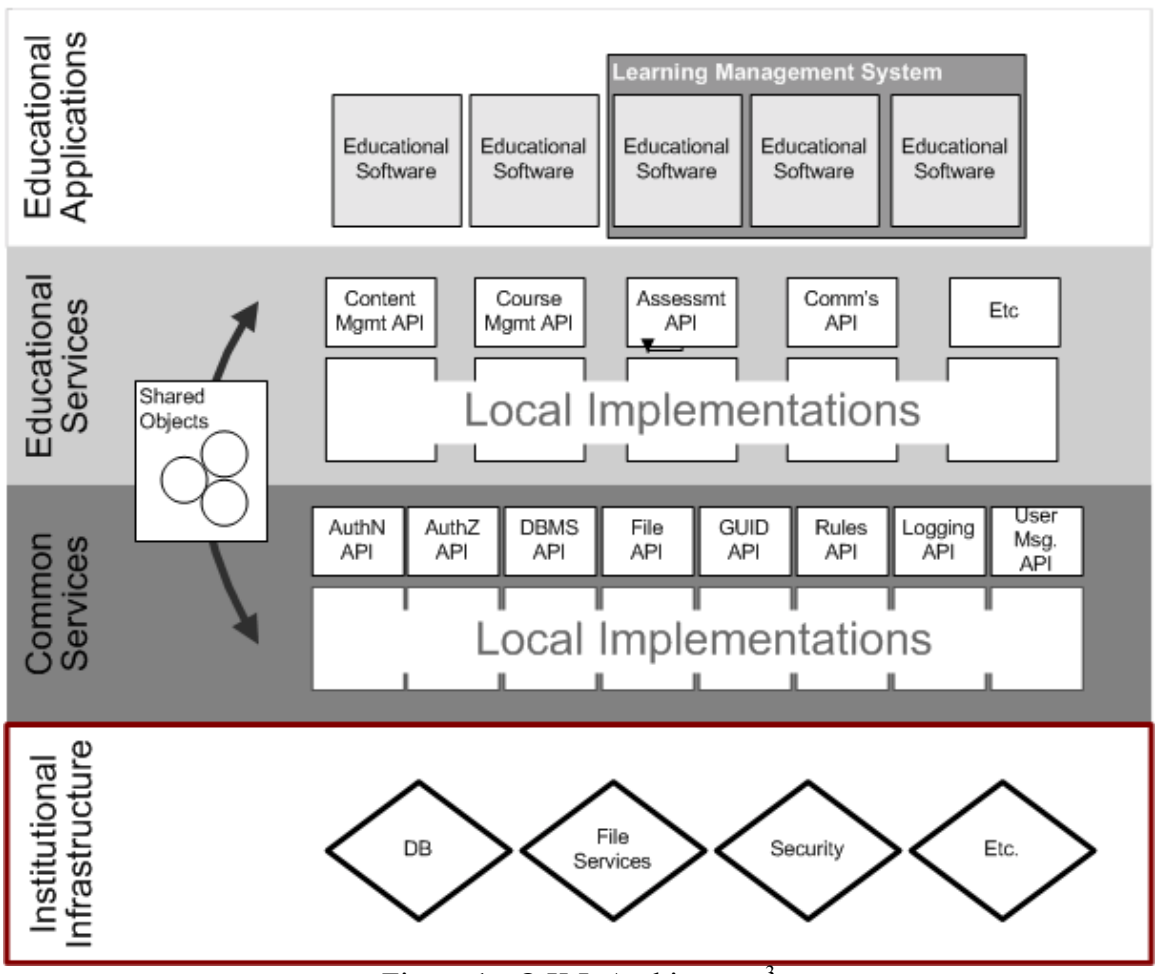


Figure 1 - O.K.I. Architecture[3]

### *Common Service APIs*

The infrastructure layer provides *services* to applications. These services include authentication (ensuring that the user is who the user claims to be), authorization (checking permissions to use a service or perform specific operations with a service), database management, logging transactions, and others (see Figure 1 - O.K.I. Architecture

In O.K.I., services are accessed via Application Programming Interfaces (APIs). The APIs must be implemented both by the appropriate infrastructure components and by the applications that use them. Once in place, APIs allow applications to use services without knowing anything about how the services themselves are implemented. For example, an API might allow an application to store a file in a campus-wide shared file system without knowing whether the file system is on a UNIX or NT platform, what type of media is used to store the files, or how access control is managed.

[3] For more detailed information, refer to the "O.K.I. Architecture Overview" on the O.K.I. web site http://web.mit.edu/oki/product/papers.html

By defining APIs that are not bound to any one implementation of a particular service, O.K.I. provides a boundary layer that buffers educational software from infrastructure. With this approach, changes in infrastructure no longer require major re-writes of code at the application level.

### *Educational Service APIs and Shared Objects*

In addition to common services offered by the institutional infrastructure, the O.K.I. architecture identifies *educational services* of direct value to educational applications. These services use and modify objects of specific interest to educational applications, such as student information, courses, and learning content.

As of the writing of this white paper, O.K.I. has begun to design the shared objects and interfaces that will support educational services in four broad areas:

- Class administration (e.g. - scheduling, enrollment, grade book),
- Content repository (e.g. - locating, launching, tracking),
- Assessment (e.g. - test services, assessment tracking), and
- Communication services (e.g. - virtual classroom, discussion boards).

### *Java*

APIs may be defined abstractly as a set of function calls and data formats or may be defined by specifying them in a particular programming language. The former is more flexible but the latter is better for implementers.

While O.K.I. has chosen to specify its service definitions as Java APIs, the intellectual effort towards building these definitions is applicable to other technology bindings. This keeps open the future possibility of expressing these services as interfaces in other object oriented languages such as C++ and C-Sharp. This also makes it possible to support services-based implementations using tools such as J2EE and .net.

### *The MIT-O.K.I. API Definition License*

An important tool for ensuring both adoption and interoperability is the O.K.I. licensing structure. O.K.I. has two types of licenses, one for APIs and one for the open source software being developed (see below).

The MIT-O.K.I. API Definition License applies to the APIs that will be released by O.K.I.. This license is designed to ensure standardization of API definitions among adopters. It promotes broad, free distribution of the standard APIs. The license allows *local* modification but maintains the integrity of the APIs by prohibiting the redistribution of modified versions. This leaves the door open for innovation and experimentation but protects the integrity of distributed APIs by ensuring that all distributed modifications occur only under O.K.I.'s control.

## 2.4 Partner Implementations

O.K.I.'s goal is to develop open architecture solutions for widespread adoption by educational institutions. To this end, O.K.I. is working closely with educational software vendors to ensure that commercially licensed systems are compatible with the O.K.I. architecture. O.K.I. will support and encourage the commercial design of innovative tools, in keeping with the overall goal of global improvement in the management and design of educational technology.

At the same time, O.K.I. partners are implementing the architecture by building it into their own learning management software. Specifically, MIT is developing an application called *Stellar,* Stanford University is developing *Course Work*, and the University of Michigan is developing *Chef.* MIT, Stanford and Michigan are looking to O.K.I. as the architecture they will use to support short-term and long-term learning technology solutions for their campuses. Initially these institutions expect to use systems and applications based on local and shared O.K.I. development efforts, but eventually they also hope to acquire products from vendors and contributing universities who provide components that comply with the API definitions and the core architectural philosophy of O.K.I..

## 2.5 Open Source Licensing

MIT, Stanford University and the University of Michigan will make their application software available through an open source MIT-O.K.I. API Implementation License that allows the source code to be freely incorporated into learning system components built by universities or by commercial software vendors[4]. This license is designed to encourage the widespread sharing of innovation among adopters, so it promotes the open distribution and modification of this software. This is a good way to demonstrate a "proof of concept" and to provide concrete artifacts that can jump start community and commercial development efforts.

This does ***not*** imply that O.K.I. is distributing and supporting a "free LMS" as a low cost alternative to commercial products. The open source software provided by O.K.I. is not complete, and does not come with a warranty, training, implementation guidelines, support services, a bug fix process, a help desk, or ongoing upgrades[5]. If an organization tries to use O.K.I. software as a basis for a production implementation, the cost of providing this support internally will likely eliminate the benefits of starting with free software.

[4] A model for open source development is the JA-SIG (Java Administration Special Interest Group - http://www.ja-sig.org/), to which MIT belongs. The O.K.I. has the potential to lead the academic directions of the JA-SIG Portal Project, through its focus on pedagogical tools, collaboration, and faculty engagement.
[5] Support services are not a question of *licensing*. Companies like Red Hat provide support services for open source software, and there is commercially licensed software that does not come with support.

# 3 Benefits of the Open Knowledge Initiative

O.K.I. is a technical initiative, but its purpose and potential benefits extend far beyond the purely technical. There are benefits for students, faculty, administrators, technologists and commercial product vendors.

### *Functional Flexibility*

The architecture enables a component approach to learning infrastructure. Institutions can, if they choose, support a range of functional components that can work together or operate independently. Faculty and instructional designers can then use the components most important to them that provide the level of functionality they need. For example, a faculty member might want to support a class with a sophisticated simulation engine and a rather ordinary discussion list while relying on paper methods for administering tests. Or a faculty member might want *only* online testing, but requires tests that include complex mathematical notation and that integrate with a computer algebra system.

Existing course management systems do not easily support this component approach. Most vendor products are all-in-one packages whose components offer a single level of functionality designed for widespread use. It is hard to selectively add or substitute specialized applications such as a those described above. The architecture provided by the Open Knowledge Initiative is intended to make it easier to provide faculty with a range of options, with the goal of supporting a more effective teaching and learning experience.

### *Stability, Reliability, and Scalability*

The O.K.I. architecture also allows components of a complex environment to be maintained and updated independently of each other, thus improving reliability and making systems more "future proof."

The Java APIs defined by O.K.I. are using an architecture that has proven to be stable and scalable in large enterprise computing environments. O.K.I.-based systems should be able to handle the demands of institutions with potentially thousands of faculty, thousands of courses, hundreds of thousands of students, multiple campuses, and students accessing courses from remote locations.

This is valuable to those responsible for purchasing and maintaining the software, and also addresses fundamental requirements for faculty, students, and administrators. As these groups become more dependent on learning technology, the reliability and performance of learning systems becomes crucial. A stable underlying architecture means that learning systems can accommodate increased demand, and that specialized tools and content developed by faculty and students will continue to run properly, even when the underlying technologies are replaced with newer versions.

### *A Catalyst for Cooperative Development*

By providing a comprehensive and standardized definition of the 'glue' that holds system components together, the O.K.I. architecture enables the sharing of learning content and software applications among schools and departments. The common architecture and common interfaces will allow schools to more easily implement components developed by other organizations, as

long as all parties conform to the architecture. This creates an environment where, for example, applications designed specifically to teach anything from advanced mathematics to simplified Chinese can be easily disseminated and used on a campus-wide, system-wide or national basis. Multiple institutions can more easily share learning technology and share in the adaptation of the technology to meet common requirements

### *A Catalyst for Commercial Development*

O.K.I. extends significant benefits to anyone developing and distributing learning technology software by giving clear guidance as to how products will integrate with one another and with campus infrastructures. This applies to individual instructional tools, to suites of instructional tools, and to more complex products that interact with other academic and administrative systems.

The existence of a standardized architecture and well-defined points of integration simplifies the product development cycle and improves customer satisfaction through better integration capabilities. The component approach supported by O.K.I. also opens the door for specialized and innovative products. Without a common integration strategy, the market for such products is often too small, and the development costs too high, to attract the attention of either public or private entrepreneurs. Put another way, O.K.I. allows all developers of technology – commercial, non-commercial, proprietary, or non-proprietary – to expend their efforts on developing pedagogically effective tools rather on than re-inventing basic services or figuring out how to integrate with them.

### *Integration with Enterprise Infrastructure and Systems*

O.K.I. will provide a clear definition of the interfaces between learning systems, campus administration systems, and campus technology infrastructure services. There are technical benefits to this, but this improved integration also benefits faculty, students and administrators by supporting capabilities such as a single sign-on for all systems, more timely sharing of student enrollment information across campus, and the automated movement of grades into the Student Administration system. It allows Universities to migrate different portions of their infrastructure at different times without disrupting the portions not being changed. Institutions can mix and match applications while retaining interoperability between their chosen student administration systems and their O.K.I.-based learning infrastructure.

### *Conformance to Industry Standards*

O.K.I. fits in with a unified international movement to create standards for learning technology. O.K.I. is using standards produced by other organizations and contributing its own work to various standards development processes. This includes partnerships with the IMS Global Learning Consortium (www.imsglobal.org), the Advanced Distributed Learning Network (www.adlnet.org) who provide the Sharable Content Object Reference Model (SCORM), and the Java Administration Special Interest Group (JA-SIG - http://www.ja-sig.org/).

Conforming to these wider industry standards will allow the higher education market to make use of content and of learning technology developed by educational institutions, government agencies and corporations around the world. It also allows higher education to develop content and offer education to a world market. Finally, it means that the technical work done by O.K.I. is validated from diverse perspectives, thereby making it more robust and less likely to overlook important aspects of learning that will require re-design in the future.

# 4 Moving Ahead With the Open Knowledge Initiative

### *The Status of O.K.I. Technology*

As of this writing, the first set of infrastructure APIs has been released and is available at the O.K.I. web site. The O.K.I. team is continuing work on infrastructure APIs, and is also moving ahead with defining APIs for Class Administration and Content Repository services. These will be released during the second half of 2002. There are open source components publicly available on the O.K.I. Web site and others will be released as they become available. MIT, Stanford University and the University of Michigan have begun adapting several of the O.K.I. common service APIs to their learning management systems.

### *The Role of O.K.I. as a Movement*

O.K.I. is a strong voice for interoperable and scalable architecture that supports a rich and effective approach to online learning. It will influence the learning technology marketplace through its APIs and through its reference implementations. Software vendors who adopt O.K.I. will compete more effectively by spending less on duplicative infrastructure development efforts. New development will be encouraged by lowering the barrier for producing specialized components that integrate into larger systems. O.K.I. will catalyze the establishment of communities of practice and innovation through its open source software. However, O.K.I. does not intend to compete in the marketplace itself, either by selling or by giving away a production grade learning management system.

O.K.I. is also very much involved with global standards development communities and movements, but its role is not so much to produce specifications as to affect their future direction through the publication and implementation of an architectural framework that incorporates them.

### *The O.K.I. Developer Community*

The O.K.I. specifications are still evolving, but developers can begin working with the overall architecture and with those APIs that have been defined. If you are in the process of developing learning technology applications and tools, then you should get involved with the O.K.I. developer community. This community welcomes the participation of development teams from any type of higher education institution and from any vendor supplying instructional technology to higher education.

### *Supporting the Open Knowledge Initiative*

Organizations who plan to support the O.K.I. technology should invest some technical resources now to learn about the architecture. Support also means making adoption of O.K.I. a requirement for development initiatives and for product purchases. You should require a clear, public statement of long term support for O.K.I. from your system vendors, and you should request specific information on which O.K.I. APIs have been implemented, and what the schedule is for the adoption of others. You should also consider identifying and proposing O.K.I.-related research, development, implementation, and testing projects, all of which have a good track record with funding agencies.

The O.K.I. architecture is an important part of the ongoing dialog about the use of learning technology in higher education. Supporting the movement means both proclaiming support for O.K.I. and considering O.K.I. in decisions on the future of education technology.

**CONTACT INFORMATION:**

**For more information about the Open Knowledge Initiative, please visit our Web site at (http://web.mit.edu/oki) or email us at (oki-info@mit.edu).**

*About the Authors: Geoff Collier and Robby Robson are senior partners in Eduworks Corporation (www.eduworks.com), offering independent consulting to e-learning producers, implementers, and product vendors. Eduworks is closely involved in the development of global e-learning standards and provides clients with information and support related to the development, selection and implementation of e-learning products.*