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EMERGING TECHNOLOGY REPORT

Experience API: Flexible, Decentralized and Activity-Centric Data Collection

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Abstract This emerging technology report describes the Experience API (xAPI), a new e-learning specification designed to support the learning community in standardizing and collecting both formal and informal distributed learning activities. Informed by Activity Theory, a framework aligned with constructivism, data is collected in the form of activity statements with the flexibility to describe a wide array of learning experiences from museum exhibits to learning environment interactions. Fast adoption by private sector tool developers and the majority of learning management systems used in academia suggests the specification may have long-term implications. This report summarizes major educational research opportunities and key challenges to implementation.

Keywords Alternative assessment · Constructivism · Activity theory · Experience API · xAPI · Tin Can API · Learning management system · Virtual learning environment

1 Introduction

The Experience API (Application Programming Interface), also called xAPI and formerly called Tin Can API, is a new e-learning specification designed to support the learning community in standardizing and collecting both formal and informal distributed learning activities. New Web standards like cloud-based storage and RESTful Web services have greatly alleviated the technical impact of data storage and transmission, respectively. However, the variety in educational data taxonomies (Verbert et al. 2012) and challenges

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involved in collecting analytically useful distributed learning events (Suthers and Rosen 2011) remain as difficult hurdles. The xAPI offers a new solution for this issue, using a student-centered approach built on current web technologies.

The xAPI specification describes packaging and transmission of learner actions called "Activity Statements" between any tool and a learning record store (LRS), the database model that validates and stores activity statements. Following a data structure similar to the innovative work of Wild et al. (2008), activity statements consist of data populating a minimum of three properties: "Actor," "Verb," and "Object." Actor data is unique information that describes a specific subject, such as a student or group of students. Verb data classifies the type of activity the actor participated in and often links to a human readable description of the event. Object data will link to an artifact that is typically a byproduct of or related to the activity.

Since xAPI activity statements closely follow the syntax of English, the majority of xAPI data is expressed in human-readable format. For example, a high school student assigned to read a book for their English class may have the following statement generated upon completion: Brittany *(actor)* read *(verb)* The Great Gatsby *(object)*. While the xAPI has predefined properties to include additional information such as context *(context)* and assessment data (*results*), the specification is designed to be extensible for unforeseen data collection needs. The number of tools to access and share information about oneself and others continue to increase every year (Duggan and Smith 2014), and the flexibility of this specification allows for the ongoing development of data collection methods.

The xAPI is funded and supported by Advanced Distributed Learning (ADL), the same group responsible for the shareable content object reference model (SCORM), the industry standard ensuring data interoperability between learning management systems (LMSs) and learning objects. Like its predecessor SCORM, the xAPI has been more readily adopted by the business community than the academic community. But inroads into LMSs commonly used in academia are occurring quickly. Sakai and Blackboard, together serving over 45 % of US higher education enrollments (Kroner 2014), have both integrated the xAPI into their LMS products. ADL considers the xAPI to be one of four primary components towards their Training and Learning Architecture (TLA), a collection of APIs and open source software initiatives that support their long-term educational research efforts (Advanced Distributed Learning 2015b).

2 Relevance for Learning, Instruction, and Assessment

2.1 Constructivist Learning

The xAPI specification is highly influenced by the socio-cultural framework Activity Theory (Silvers 2014) as initially developed by Lev Vygotsky (1978) and re-envisioned by Engeström (2001). Indeed, even the unit of analysis, the activity, is the same for both Activity Theory (Kuutti 1996) and the xAPI (Silvers 2014). Activity Theory's close alignment with constructivist learning theory (Jonassen and Land 1999), which frames learning as individualized meaning-making, and social constructivist theory, which emphasizes the value of social interaction in that knowledge construction (Richey et al. 2011), has potential implications for future work. If the majority of instructional designers self-identify as constructivists, as suggested by Richey et al. (2011), then the xAPI provides a new approach for designers to implement constructivist-aligned strategies from design through evaluation.

2.2 Learning Analytics

Berland et al. (2014) define learning analytics as, “a set of methods that apply data mining and machine learning techniques such as prediction, classification, and discovery of latent structural regularities to rich, voluminous, and idiosyncratic educational data” (p. 206). With the majority of analytics tools designed from behaviorist perspectives (Drachsler and Greller 2012), new fertile ground for constructivist-based analytics research utilizing a widely accepted specification may be presenting itself. It is critical to utilize common semantics (Mwanza and Engeström 2005) and to collect user experience data in a method that is aligned with the learning environment’s pedagogical perspective (Lim 2002). Combining the xAPI with recent work in Activity Theory-designed instruction (Bozalek et al. 2015) and constructivist learning environments (Jonassen and Ronrer-Murphy 1999) may highlight undiscovered educational affordances. Because of the wide variety of models for virtual learning environments (VLEs) (MacNeill and Kraan 2011), the xAPI is ideally suited to integrate into these models as a component for logging learning analytics.

2.3 Collecting Lifelong Learning

Virtual learning environments, also known as LMSs, provide technical infrastructure to manage all student interaction with digital learning content (Watson and Watson 2007). LMSs have achieved nearly 100 % adoption amongst institutes of higher education (Dahlstrom et al. 2014). Students visit the Web page for their institution’s LMS, authenticate themselves, and then consume content related to their courses through these centralized and monolithic systems. Announcements, reading materials, grades, and assessments are all accessed in this fashion in a streamlined and controlled process that has facilitated the growth of “anytime, anywhere” instruction (Berking and Gallagher 2014). However, as Groom and Lamb (2014) point out, the enterprise level of integration LMSs achieve at institutions tie up financial resources and provide a barrier against “homegrown, open-source, and user-driven innovation.” Additionally, LMS design carries with it the general assumption that learning occurs in discrete modularized steps within the system (Wilson et al. 2006), and provide limited structure for the importance of non-formal and lifelong learning events central to educational approaches like competency-based education (Glowa 2013; Book 2014).

The xAPI can decouple or augment learning event data from a LMS, allowing for the distribution and recognition of learning content experienced across disparate systems. With student permission, this opens up access to students’ activities like interaction with mobile learning applications, museum exhibits, or any data that can be pushed to the cloud, similar to the personal learning environment (PLE) conceptual model that Wilson et al. (2006) presented. If the xAPI continues to be adopted, the specification can support a wide variety of learning experiences, maintain structured data collection with a LRS, and provide a method of recording an individual’s lifelong learning experience (Fig. 1).

3 Emerging Technology in Practice

In 2013, ADL exited the active development phase of the xAPI with the release of version 1.0. Since that time, community members and partners have begun to build upon the stable platform. ADL maintains a public list of xAPI adopters to encourage the sharing of

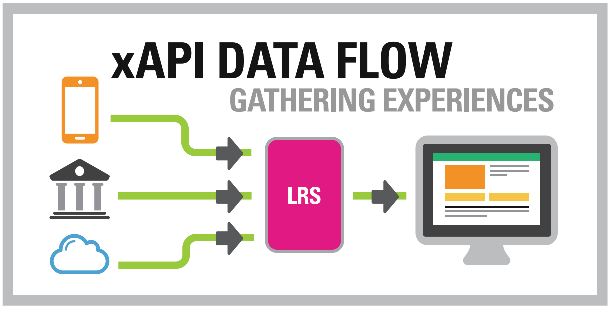

Fig. 1 xAPI data flow, credit: Loni Takeoka

knowledge among community members (Advanced Distributed Learning 2015a) and increasing interoperability between educational technologies. Notable among these adopters is Adobe, which has integrated xAPI as an output format for its Captivate responsive e-learning platform. Any content created in Captivate can be configured to deliver the results of student interactions to an LRS via xAPI statements. Similarly, the iSpring Suite, a popular tool for packaging presentation slides for web consumption with quizzes and other interactions, can deliver progress and completion results to an LRS via xAPI statements. Other popular e-learning creation tools, such as Articulate's Storyline 2, have begun to include basic xAPI integration, such as the ability to report which slides were viewed by a particular student. Finally, other companies are beginning to create gamified learning experiences, such as the Knowledge Guru (Bottom-Line Performance 2014), which tracks all user interactions via xAPI statements and submits them to a connected LRS.

There is still little research on the educational implications, efficacy, or implementation of the specification. The timeline from research to publication and limited xAPI end-user tools has likely slowed the publication of research-based articles. Most publications focus on the perceived value of the xAPI from various disciplinary perspectives, such as this article, or outline works in progress for areas such as xAPI data collection in kinesthetic learning (Megliola et al. 2014) and mobile learning (Glahn 2013). However, publications beginning to explore best practices (Kitto et al. 2015) have started to appear. It is still unclear if the xAPI, or activity-based data tracking tools in general, will gain significant presence in the academic research community.

4 Significant Challenges and Conclusions

4.1 Data Security

Learner data policy and security is still a challenging issue, particularly when trying to maximize student protection while enabling valuable analytic tools, as noted by Prinsloo and Slade (2013). However, since xAPI statements are uniquely associated with students via email addresses, some layer of protection is required by the application serving learning content and the server hosting the LRS to ensure that the individual using an email address is its true "owner." Learning content applications must verify somehow that an individual owns the email address they are registering with the application (typically via verification emails or the authentication service offered by their institution). Similarly, the

LRS cannot simply accept all learning event statements given to it, so it must have some way of establishing trust with the learning content applications that send it statements (typically through the generation of a secret key that the LRS grants to each individual learning application to track the statements it submits).

4.2 Changes in the Spec Over Time

The xAPI spec was introduced (version 0.8) in 2012, and finalized (version 1.0) in 2013. As of this writing, the latest release is version 1.0.2 (October 1, 2014). It is therefore a very young specification, and does not (yet) have historical evidence for its success. That said, if it is considered as a successor or extension to SCORM, it has a much larger history of success upon which to judge. Additionally, the ADL initiative, sponsored and funded by the US Department of Defense, has committed itself to the roles of steward and facilitator of the spec.

The largest change in the spec occurred in the move from version 0.9 to 0.95, when the core verbs defined in the specification were removed. These core verbs were, in essence, the most common action verbs that ADL expected to be used in learning statements. However, rather than engage in a semantic battle about the nuances of meaning (e.g., does “experienced” mean “passively viewed” or “synthesized knowledge from”?), ADL instead chose to leave the definition of verbs entirely up to the community that builds upon the xAPI.

Further changes of this magnitude are still possible. Community involvement was the trigger for the removal of core verbs in favor of community-defined verbs, so it is conceivable that further community involvement and adoption may lead to similar changes. Additionally, as the xAPI seeks IEEE standardization, there is the possibility of major changes to meet additional requirements.

4.3 Technical Hurdles of Installation and Setup

In order for xAPI statements to have meaning, they must be associated with some artifact of the activity performed (e.g., a multiple choice quiz). However, to encourage adoption, the xAPI spec imposes little control over the definition of these “activities” other than (1) every statement must be associated with one, and (2) they must have a unique URL (which may or may not be accessible). The xAPI itself does not impose meaning on the statements in a broader context–this must be done by some other rubric or external certification process.

With this in mind, simply adopting the xAPI specification and configuring a learning content application and LRS repository will not be successful without some other system in place to prescribe meaning to and relationships among activities, experiences, and larger learning goals. ADL has begun to foster and support xAPI communities of practice around specific educational domains and tools such as health care, augmented reality, and eBooks. The objective of these communities is to create standard vocabularies for xAPI users and tool producers within that specific user base (Advanced Distributed Learning 2015c), but this initiative is still young and adoption levels have yet to be assessed.

Therefore, the primary technical hurdles of adoption are integrative, i.e., the disparate systems must all agree on the prescribed meanings of the verbs and activities used in xAPI statements, and on the meaning that certain groupings of statements have. It should be noted that this is not considered a failing of the spec itself, but rather an indication of its role in a larger set of technologies:

> The Experience API is the first of many envisioned technologies that will enable a richer architecture of online learning and training. Authentication services, querying services, visualization services, and personal data services are some examples of additional technologies which the Experience API is designed to support. While the implementation details of these services are not specified here, the Experience API is designed with this larger architectural vision in mind. (Advanced Distributed Learning 2013)

4.4 Implications for Theory and Practice

The xAPI offers a renewed opportunity to research, develop, and explore theories involving learning beyond academia's digital environments. The staying power and continued adoption rate of the technology has yet to be determined, as well as whether it will hold up to its proposed value for educational practice. However, fast adoption by major LMSs and a claim of long-term support by ADL are promising signs of a potentially impactful technology. The xAPI's strong theoretical foundation and similarities to other technologies, such as Contextualized Attention Metadata (Schmitz et al. 2011) and the learner interaction scripting language (Wild et al. 2008), provide strong starting points for exploring this technology's value.

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