VisCa: A Dashboard System to Visualize Learning Activities from E-learning Platforms

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Abstract. With the advance of ICT technology, the e-learning platform from higher education to K12 becomes increasingly prevalent in recent years. Furthermore, as the emerging trend of data science, several educational platforms have introduced learning analytics and data-driven learning in their system, leading to more adaptive and personalized learning services. Therefore, it is crucial time to develop a mechanism to manage and visualize the data of learning experience. To achieve this goal, we created a web-based dashboard system called VisCa to track, store, and show learning experience from e-learning platforms. The data model is based on the standard of Experience API (xAPI) to communicate with third-party platforms. The whole system brings a general framework for the data flow of learning experience, as well as supports the students and teachers to understand their leaning status. The development of this study will provide an infrastructure to collect the data of learning activities, which can be used for further learning analytics or data-driven learning in the future.

Keywords: Data visualization · Learning analytics · Learning record store · Experience API

1 Introduction

The advance of cloud computing provides a convenient environment to share all kinds of information on network, and leads to various innovations and online applications in recent years. It has also given rise to the development of many e-learning platforms, which aimed at self-learning students and open access through the network. The appearance of these platforms not only has the effect of amplifying the conventional and social use of network environments, but also contributes the use of educational technology in all possible contexts. Many platforms provide a large number of open courses to all students, and serve interactive user forums or communities between students and professor 1. Some adaptive or personalized learning platforms, such as Knewton or Smart Sparrow, can based on student's proficiency in the platform to provide directions about learning pathway, or to give suggestions of learning materials 2. With the pervasiveness of e-learning environment, we have more opportunities to analyze the learning behavior or pattern from learners. When a user regularly accesses learning services on an e-learning platform, data of activities on the platform can be

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quickly accumulated, and these data can promote the research of learning analytics or educational data mining 3. Learning analytics is a new research area that has rapidly gained attention in recent years. The purpose of learning analytics is to understand and optimize the learning environment for a learner, and it includes the study of measurement, collection, analysis and reporting of learning data 45. There are several research teams focusing on the learning data extracted from e-learning platforms 67. For example, a large-scale study of video engagement on edX platform indicates that the characteristics of videos are related to students' engagement 8. Another research teams on Coursera also explored the video lecture interaction to see the relation between watching sessions and students' engagement 9. Moreover, the low-level data in the form of user events are transformed as high-level parameters to evaluate the engagement and learning process on the platform of Khan Academy 10. Therefore, considering the above research cases on MOOCs, the long-term user events stored on the e-learning platform provide a good data resource for the presentation of students' learning status, and for the large-scale researches on learning behaviors.

However, there is no generally standard data model for user records, and this fact reduces the interoperability of learning events in different platform. Hence, a standard specification, called as Experience API (xAPI), was currently developed by Advanced Distributed Learning (ADL) to solve the problem 11. The purpose of this standard is to store and access the learning experiences by a unified format. It describes an interface and the retrieval rules that can record the detail events of learners' actions, including watching a video, taking an assessment, or reading an e-book. After tracking on learning experiences from users through the xAPI, the experience data will be delivered to and stored in a database called learning record store (LRS), which can be subsequently used as the data source of learning analytics and visualization. In our work, we created a dashboard system called VisCa to catch all kinds of learning experience from e-learning platform, and visualized these data by several dashboards on the web. VisCa can help students and teachers leverage the latest learning experiences by xAPI standard, and solve data silos problems and support innovative learning designs and technologies without limit. Because of the structure and semantic interoperability of xAPI, VisCa can integrate and visualized data from different systems or applications. The statistical result of experience data shown in dashboards can represent the learning status, behavior, or pattern across diversity platforms. The real-time data feedback loops aim to benefit instructors, learners, administrators and product developers, and will be used to support data-driven learning.

2 Overview of System

2.1 The Standard of Experience API

To enable tracking on learning experiences, the xAPI is designed to allow the statements of experience to be delivered to and stored in an LRS. The format of these statements is based on activity stream to syndicate activities across social web applications and services. A statement is composed of three principal fields including actor, verb, and object. The actor is the agent which the statement is about, such as a learner, teacher, or

Table 1. Properties of xAPI statement

Properties	Description
Actor	Indicate an agent or group object
Verb	Represent the action between Actor and Object
Object	Indicate the target what the Actor interacted with
Result	Show a measured outcome related to the statement
Context	Provide a place to add contextual information to a statement
Timestamp	Record the time at which the learning experience occurred
Stored	Record the time at which a statement is stored into LRS
Authority	Provide information about whom or what asserted that this statement is true
Version	xAPI specification version
Attachments	A digital artifact providing evidence of a learning experience

group. The object represents what the actor interacted with, and can be any learning material such as videos, tests, or books. The verb is the interaction between the actor and the object, so that it depends on the type of objects. In addition to three basic fields, there are some extra properties to supplement an xAPI statement as shown in Table 1.

For each property in a statement, there are still sub-properties to describe the details of the property, and that means the structure of a complete statement is hierarchical. Therefore, as shown in the Fig. 1, an xAPI statement is stored in JSON format, which is an open standard format that can represent hierarchical data object with the form of attribute-value pairs. Based on the xAPI standard, we designed several data recipes to communicate with the third-party e-learning platforms.


```
"id": "2a1cf4dc-364b-463f-975f-d4dfd9548cb9",
"actor": {
    "objectType": "Agent",
    "mbox": "mailto:tyler@example.com"
},
"verb": {
    "id": "http://example.com/verbs/highlighted",
    "display": {
        "en-US": "highlighted"
    }
},
"object": {
    "objectType": "Activity",
    "id": "http://example.com/activities/paragraph%207"
},
"result": {
    "response": "insightful"
},
"context": {
    "contextActivities": {
        "parent": [
            {
                "objectType": "Activity",
                "id": "http://example.com/activities/page%209",
                "definition": {
                    "name": {
                        "en-US": "page 9"
                    },
                    "description": {}
                }
```


Fig. 1. The format of an xAPI statement

2.2 System Architecture

We used the MongoDB, which supports JSON-like documents, as our LRS to store all xAPI-based learning records. The learning experience from the users in third-party platform will be transferred into our LRS via xAPI statements. The low-level user events will be tracked as learning behaviors when students watch an online video and e-book, or take an assessment in an e-learning platform. We also created a wrapper module which can be quickly used or embedded for any e-learning platform to generate standard learning records. After processing and analyzing the raw data of learning experiences data in LRS, some visualized dashboards via a web server are provided for students and teachers to see their learning pattern. We show the flowchart of the system architecture in Fig. 2, as well as the web page of dashboard system in Fig. 3.

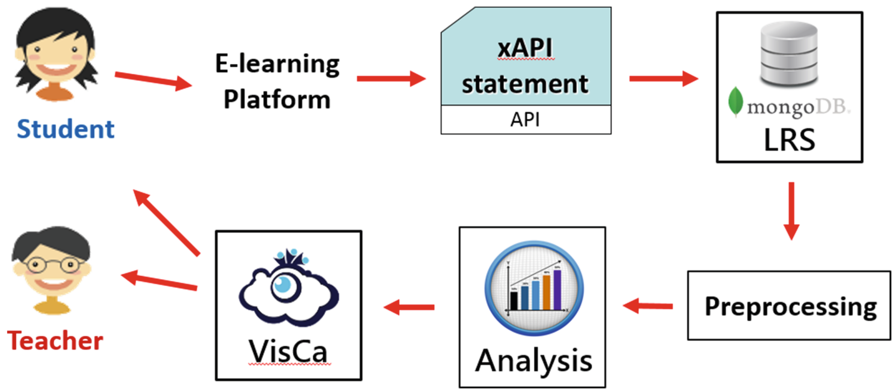

Fig. 2. The flowchart of system architecture

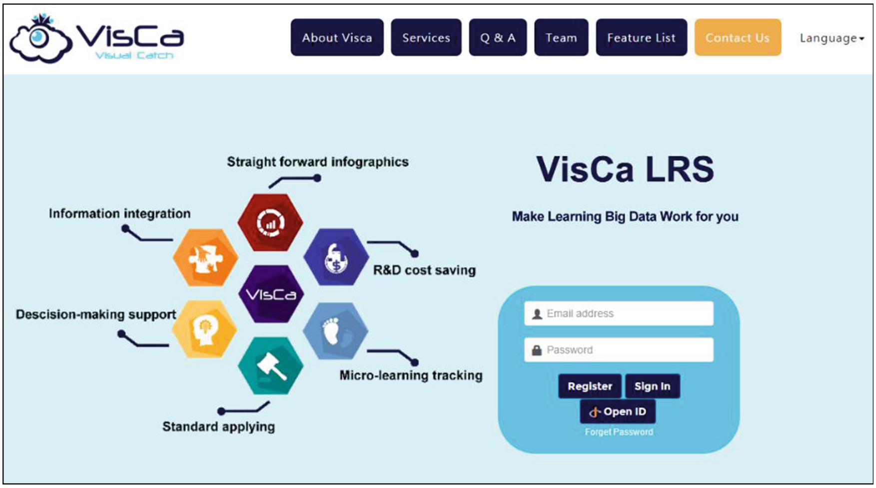

Fig. 3. The web page of VisCa

2.3 Dashboard of Learning Experiences

As concern as the friendly representation of learning records in LRS, a dashboard which can show the statistics of learning behaviors is needed. A student can see the learning pattern or style in the learning platform, while a teacher can check the usage of learning materials and improve them. Four kinds of dashboard showing the statistics of learning records were depicted in Fig. 4. The overview of collected learning records in recent days is shown in Fig. 4A. The level of engagement of different kinds of materials including video, e-book, practice, or assessment, is illustrated in Fig. 4B. The watching pattern for a video and the assessment result in a class are shown in Fig. 4C and D, respectively. These dashboards enable students, teachers, web administrators, and researchers to view the statistics of their learning records in a favorable way, and these visualization can be used as a report of learning status of each student, or as a summary of the usage of learning materials in an e-learning platform.

Fig. 4. Dashboard of learning records

3 Conclusion

The learning activities generated by users in an e-learning platform can be used to improve the learning processes or provide more personalized learning services. These data-driven learning will be the trend of learning and education in the future. Therefore, the VisCa system, which automatically retrieve learning activities from users and represent the dashboards of learning status, can provides the feedback loops from visualization to benefit instructors and learners. The contribution of our work is to provide a systematic architecture to deal with the enormous and unorganized data of learning activities, and primarily show how we can use these learning data via some dashboards of visualization. The goal behind the work in this study is to build a standard model to process and represent the learning data, and it will benefit to further learning analytics or data-driven learning in the future.

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