NGDLE Learning Analytics: Gaining a 360° View of Learning

The Problem: Stove Pipes of Learning Platforms

A key part to the NGDLE is a central repository for learning analytics. Without a central repository, the learning environment becomes compartmentalized and stove-piped making it difficult to provide a 360° view of the learner and learning environment. This makes it much more difficult to have a combined view of student learning activities.

Stove-piped systems with no integration
Solution: Learning Record Store

The Apereo Open Learning Record Warehouse is a promising Open Source repository to provide this 360° view.

1. Allows multiple feeds of xAPI and Caliper data to one repository.
2. Presents integrated view of student activity gathered from data sources. Examples: LMS, Video repositories, ePortfolio used in courses; 3rd party tools that are xAPI or Caliper compliant.
   a. Other sources: data from ID card tracked activities -- such as guest lecture attendance
   b. Other sensor data (multi-modal analytics)
3. Is near real-time depending on the latency of data sources.

An Integrated Central Repository
OVERVIEW OF OPEN APEREO LEARNING WAREHOUSE

At Notre Dame we are in the process of implementing all of the above with the exception of the Hadoop predictive analytics module. We are evaluating the predictive analytics to determine how they might best be utilized at Notre Dame.

This framework has been implemented at several US universities including Marist College, Savannah State University, College of the Redwoods, Cerritos Community College, North Carolina State University and parts of this framework have been adopted by the large Jisc initiative on learning analytics in the UK involving 50 universities. The University of Michigan is also using the Learning Record Warehouse component of the framework.
Notre Dame’s Implementation of Apereo Open Learning Record Warehouse

Because our University has an ongoing Cloud First initiative, we implemented the framework in our Amazon AWS instance. The architectural diagram is shown below:
Sample Data and Visualization

H5P sample data shows student “Xiaojing Duan” answered the “H5P True or False Example: Climate and Natural Vegetation...” question and scored “1.0”: (H5P is a tool for the creating rich and interactive learning objects.)

Sample radar chart shows different students’ scores on different H5P questions:
Kaltura sample data shows student “Xiaojing Duan” watched the video “Video1-Introduction” and stopped at 50%:

```json
{
  "_class": "unicom.mathews.caliper.service.repository.MongoEvent",
  "userRef": "mailto:Xiaojing.Duan@umd.edu",
  "organizationId": "8abd93b809f7c15e0d968598",
  "tenantId": "58d93b809f7c15e0d968598",
  "event": {
    "id": "d681521e-279e-4b36-a99c-1f47cf3b6c12",
    "context": "http://purl.imsglobal.org/caliper/v1/Event",
    "agent": {
      "id": "mailto:Xiaojing.Duan@umd.edu",
      "type": "foaf:box",
      "context": "http://purl.imsglobal.org/ctx/caliper/v1/Context",
      "name": "Xiaojing Duan",
      "extensions": {} } },
  "action": "http://activitystrea.ms/schema/1.0/watch",
  "object": {
    "id": "https://4124b1.kaf.kaltura.com/media/t/1_8tvvi6t",
    "type": "http://adlnet.gov/expapi/activities/video",
    "context": "http://purl.imsglobal.org/ctx/caliper/v1/Context",
    "name": "Video1-Introduction"
  },
  "generated": {
    "id": "8c810e5e-68a7-4c95-a617-a6ad2558a8c2",
    "type": "http://purl.imsglobal.org/caliper/v1/Result",
    "context": "http://purl.imsglobal.org/ctx/caliper/v1/Context",
    "extensions": {
      "https://xsi3.org/xapi/caliper/extensions/progress": 50,
      "actor": {
        "id": "mailto:Xiaojing.Duan@umd.edu",
        "type": "foaf:box",
        "context": "http://purl.imsglobal.org/ctx/caliper/v1/Context",
        "name": "Xiaojing Duan",
        "extensions": {} } },
  "eventTime": "2017-08-15T16:12:16Z" }
}
```

Sample gauge chart shows the maximum percentage of “Video1-Introduction” watched by different students:
Sakai Tests & Quizzes sample data shows student “Xiaojing Duan” scored “10.0” in the “Introduction” quiz:

```json
{
  "class": "unican.matthews.caliper.service.repository.MongoEvent",
  "userid": "xduan",
  "organizationid": "S8d963e069f7c11e7df8e59b",
  "tenantid": "S8d963e069f7c11e7df8e59b",
  "event": {
    "id": "bc167446-d3c8-4afe-8e63-a871ea6956e6",
    "context": "http://purl.imsglobal.org/caliper/v1/Event",
    "agent": {
      "id": "xduan",
      "type": "https://github.com/adlnet/xAPI-Spec/blob/master/xAPI.md#agentaccount",
      "context": "http://purl.imsglobal.org/ctx/caliper/v1/Context",
      "name": "Xiaojing Duan",
      "extensions": {
        "HOMEPAGE": "https://sandbox-sakai.nd.edu"
      }
    },
    "action": "http://www.adlnet.gov/expanse/verb/scored",
    "object": {
      "id": "https://sandbox-sakai.nd.edu/portal/assessment",
      "type": "http://adlnet.gov/expanse/activities/received-grade-assessment",
      "context": "http://purl.imsglobal.org/ctx/caliper/v1/Context",
      "name": "User received a grade",
      "description": "User received a grade for their assessment: Introduction; Submitted: on time"
    },
    "generated": {
      "id": "da2f482b-78e1-f2e8-86f9-74b31f0f0df4",
      "type": "http://purl.imsglobal.org/caliper/v1/Result",
      "context": "http://purl.imsglobal.org/ctx/caliper/v1/Context",
      "actor": {
        "id": "xduan",
        "type": "https://github.com/adlnet/xAPI-Spec/blob/master/xAPI.md#agentaccount",
        "context": "http://purl.imsglobal.org/ctx/caliper/v1/Context",
        "name": "Xiaojing Duan",
        "extensions": {
          "HOMEPAGE": "https://sandbox-sakai.nd.edu"
        }
      },
      "totalScore": 10.0
    },
    "eventTime": "2017-06-26T13:54:53Z"
  }
}
```

Sample bar chart shows different students’ scores in the “Introduction” quiz:

![Sample bar chart](image-url)
Since all the data from different sources is stored in a centralized Learning Record Warehouse, we can easily merge them and gain a 360° view of students' learning behavior and study the correlation between that and their learning outcomes. Sample bar chart below shows students' quiz scores vs their video watching and transcript clicking activities:
Next Step

Our next step is to create dashboards of students online learning activities and share them with instructors directly from our LMS - Sakai.

Sample dashboard shows all students’ activity in the “Introduction to Organic Chemistry” class:

<table>
<thead>
<tr>
<th>First Name</th>
<th>Last Name</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mookie</td>
<td>Betts</td>
<td>348</td>
</tr>
<tr>
<td>Emma</td>
<td>Betts</td>
<td>313</td>
</tr>
<tr>
<td>Nicole</td>
<td>Betts</td>
<td>344</td>
</tr>
<tr>
<td>Raymond</td>
<td>Betts</td>
<td>510</td>
</tr>
<tr>
<td>Wyatt</td>
<td>Bird</td>
<td>348</td>
</tr>
<tr>
<td>Kara</td>
<td>Bird</td>
<td>637</td>
</tr>
<tr>
<td>Mark</td>
<td>Bird</td>
<td>563</td>
</tr>
<tr>
<td>Joan</td>
<td>Bird</td>
<td>501</td>
</tr>
<tr>
<td>Gary</td>
<td>Brady</td>
<td>315</td>
</tr>
<tr>
<td>Nicole</td>
<td>Cirusio</td>
<td>322</td>
</tr>
<tr>
<td>Jessica</td>
<td>Cirusio</td>
<td>560</td>
</tr>
<tr>
<td>Eila</td>
<td>Cirusio</td>
<td>543</td>
</tr>
<tr>
<td>Mark</td>
<td>Cirusio</td>
<td>517</td>
</tr>
<tr>
<td>Wyatt</td>
<td>Cirusio</td>
<td>316</td>
</tr>
</tbody>
</table>

Sample dashboard shows student Mookie Bett’s activity in the “Introduction to Organic Chemistry” class:
Lessons Learned:

- Gaining insights from learning analytics is dependent on the richness of the activity data gained from the various parts of the learning ecosystem. For example, if the LMS is used simply as a central file storage for powerpoints or pdf files you will not get much insight into student engagement. If using online quizzes, assignments, embedded videos and interactive learning objects you will gain a richer view of student engagement in the learning records, dashboards and, ultimately, better predictive analytics.
- The Learning Record Store/Warehouse is dependent on learning platforms’ compliance with the xAPI and Caliper standards. Because Caliper is new, not many platforms are providing API data conforming to that standard. Kaltura, for example, is one of the few multimedia vendors that now supports Caliper. Also, although xAPI is an older standard and more vendors provide data meeting that standard, it is a ‘looser’ standard so sometimes adjustments need to be made to xAPI feeds to provide all the data that is required. For example, our own Sakai LMS was not providing course site consistently in xAPI feeds, so we needed to do a fix to Sakai.
- The Apereo Open Source Learning Analytics is evolving, so the framework components have changed considerably from the original version. This has required more time to perform the upgrade being presented in the poster session than we originally anticipated. The advantage to open source is that you have more control over your analytics, but it does require more time and resources to set up the environment.

References:

1. Apereo Learning Analytics:
   https://www.apereo.org/communities/learning-analytics-initiative
2. Slideshare from North Carolina State University
3. Learning Record Warehouse:
   https://www.unicon.net/services/learning-analytics/apereoLRW
4. Jisc Learning analytics (United Kingdom)

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