



#### **A Reference Model for Learning Analytics**

#### - ISO/IEC JTC 1/SC 36 WG8 -

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## Contents

- Introduction to learning analytics
- Reference model for learning analytics systems
- Implementation of the reference model
- Conclusion and future work

## Learning analytics

- the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs
- Workflow of Learning Analytics Systems



## Reference model

- an abstract framework or domain-specific ontology consisting of an interlinked set of clearly defined concepts
- a standard model used to specify system requirements in an implementation- independent manner



## Learning analytics system project





# Requirements for the reference model

- Open and extensible:
  - new sensors, new task workflows
- Distributed:
  - multiple sources of data and functionalities distributed over multiple systems.
- Interoperable:
  - various learning platforms or virtual learning environment
- Reusable and configurable:
  - modular building blocks
- Real-time and predictable:
  - real-time constraints, estimate the time to completion.
- Usable:
  - data visualization and monitoring
- Secure and traceable:
  - privacy, data governance

## Workflow Example



#### Proof of Concept for the Reference Model



### Data collection



## Data storing/filtering



## Data storing/filtering



### **Data Analysis**



# Analyzing



### Visualization



## Visualization



## **Details – Visualization Manager**

work flow



### Feedback



### **Reference Architecture**



### Deployment architecture



#### Reference Architecture: Sequence Diagram



## **Test Scenario**

- Learning activity:
  - open digital textbook on Readium-JS viewer
- Data Collection:
  - IMS Caliper sensors capture data and send to an event store
- Data storing/filtering
  - data are transformed into uniform RDF triples and stored to the analytics data store
- Analyzing
  - statistical analysis performed using the R
- Visualization
  - dashboard showing real-time student activity data

#### [DEMO] 1. open digital textbook on Readium-JS viewer

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#### [DEMO] 2. Reading activities on Readium-JS viewer



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133	200	HTTP	intercode.iptime.or	/epub/2015/06/UCJXNOIZ	4,630	public,	application/	chrome	@type=http://purl.imsglobal.org/caliper/v1/lis/CourseSection
134	304	HTTP	intercode.iptime.or	/epub/2015/06/UC3XNOIZ	0	public;		chrome	lastModifiedTime=1434894880281
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137	200	HTTP	intercode.iptime.or	/epub/2015/06/UCJXNOIZ	279,412	public	image/pro	chrome	lastModified1ime=1434895007606
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#### [DEMO] 3. Reading activity data converted to the RDF format

```
"@context":"http://purl.imsglobal.org/ctx/caliper/v1/ViewEvent",
"@type":"http://purl.imsglobal.org/caliper/v1/ViewEvent",
'actor"∶{
  "@id":"http://www.intercode.kr/user/userOO1
  "@type":"http://purl.imsglobal.org/caliper/v1/lis/Person",
  "name":"tester
  "properties":{}
  "lastModifiedTime":1418283997868
,
action":"viewed",
"object":{
___@id":"http://www.intercode.kr/contents/a.html_,
  "@type":"http://purl.imsglobal.org/caliper/v1/Reading",
"name":"B Section",
  "properties":{},
"objectType":[],
  "alignedLearningObjective":[],
  "keyword":[],
"partOf":{}.
  "lastModifiedTime":1418283997868.
  "frame":{
"@id":"http://www.intercode.kr/contents/a-1.html".
    "@type":"http://purl.imsglobal.org/caliper/v1/Frame".
     "name":"B Section",
    "properties":{},
"objectType":[].
     "alignedLearningObjective":[],
    "keyword":[],
"partOf":"http://www.intercode.kr/contents/a.html",
     'lastModifiedTime":1418283997868,
    "index":1
 -}
},
generated":null,
'edApp"{
  "@id":"http://www.intercode.kr/software/contents-viwer",
  "@type":"http://purl.imsglobal.org/caliper/v1/SoftwareApplication",
"name":"Contents Viwer".
  "properties":{},
"lastModifiedTime":1418283997868
ˈɡroup":{
"@id":"http://www.intercode.kr/group"
  "@type":"http://purl.imsglobal.org/caliper/v1/Group",
"name":"group",
  "properties":{}
  "lastModifiedTime":1418283997868,
  "organization":
     "@id":"http://www.intercode.kr/part"
    "@type":"http://purl.imsglobal.org/caliper/v1/lis/Organization",
    "name":"team a",
"properties":{}
    "lastModifiedTime":1418283997868,
     "parentOrg":{}
  courseSection": {
"@id":"http://www.intercode.kr/course/section!"
    "@type":"http://purl.imsglobal.org/caliper/v1/lis/CourseSection",
"name":"course 1",
     "properties":{}.
    "lastModifiedTime":1418283997868,
     "parentCourse":{}
"startedAtTime"∶O,
"endedAtTime":O.
"duration":O
```

khttp://purl.imsglobal.org/ctx/caliper/v1/ViewEvent/1> :actor <http://www.intercode.kr/user/user001>; :startedAtTiem "0"; :context <http://purl.imsglobal.org/ctx/caliper/v1/ViewEvent>: :action "viewed"; :type <http://purl.imsglobal.org/caliper/v1/ViewEvent>; :object <http://www.intercode.kr/contents/a.html>: :edApp <http://www.intercode.kr/software/contents-viwer>; group <http://www.intercode.kr/group>. <http://www.intercode.kr/user/user001> :lastModifiedTime "1418283997868": :name "tester": :type <http://purl.imsglobal.org/caliper/v1/lis/Person>. <http://www.intercode.kr/contents/a.html> :lastModifiedTime "1418283997868"; :name "B Section"; :type <http://purl.imsglobal.org/caliper/v1/Reading>; :frame <http://www.intercode.kr/contents/a-1.html>. <http://www.intercode.kr/contents/a-1.html> :partOf <http://www.intercode.kr/contents/a.html>; :lastModifiedTime "1418283997868"; :name "B Section": :index "1"; :type <http://purl.imsglobal.org/caliper/v1/Frame>. <http://www.intercode.kr/software/contents-viwer> :lastModifiedTime "1418283997868"; :name "Contents Viwer"; :type <http://purl.imsglobal.org/caliper/v1/SoftwareApplication>. <http://www.intercode.kr/group> :courseSection <http://www.intercode.kr/course/section1>; :lastModifiedTime "1418283997868"; :organization <http://www.intercode.kr/part>; :name "group"; :type <http://purl.imsglobal.org/caliper/v1/Group>. <http://www.intercode.kr/course/section1> :lastModifiedTime "1418283997868"; :name "course 1"; :type <http://purl.imsglobal.org/caliper/v1/lis/CourseSection>. <http://www.intercode.kr/part> :lastModifiedTime "1418283997868"; :name "team a"; :type <http://purl.imsglobal.org/caliper/v1/lis/Organization>.

ViewEvent data in JSON format

ViewEvent data in RDF format

#### [DEMO] 4. Collected data on event store

S	р	0
http://demo.uos.ac.kr/sample.user001	http://demo.uos.ac.kr/name	"Son"
http://demo.uos.ac.kr/software/testapplication	http://demo.uos.ac.kr/name	"TestApplication"
http://demo.uos.ac.kr/reading16	http://demo.uos.ac.kr/name	"Page7"
http://demo.uos.ac.kr/reading10	http://demo.uos.ac.kr/name	"Page6"
http://demo.uos.ac.kr/reading9	http://demo.uos.ac.kr/name	"Page8"
http://demo.uos.ac.kr/reading14	http://demo.uos.ac.kr/name	"Page9"
http://demo.uos.ac.kr/reading18	http://demo.uos.ac.kr/name	"Page10"
http://demo.uos.ac.kr/reading1	http://demo.uos.ac.kr/name	"Page11"
http://demo.uos.ac.kr/reading2	http://demo.uos.ac.kr/name	"Page13"
http://demo.uos.ac.kr/reading8	http://demo.uos.ac.kr/name	"Page14"
http://demo.uos.ac.kr/reading7	http://demo.uos.ac.kr/name	"Page15"
http://demo.uos.ac.kr/reading5	http://demo.uos.ac.kr/name	"Page16"
http://demo.uos.ac.kr/reading3	http://demo.uos.ac.kr/name	"Page17"
http://demo.uos.ac.kr/reading4	http://demo.uos.ac.kr/name	"Page18"
http://demo.uos.ac.kr/reading6	http://demo.uos.ac.kr/name	"Page21"
http://demo.uos.ac.kr/reading15	http://demo.uos.ac.kr/name	"Page1"
http://www.intercode.kr/contents/assessment	http://demo.uos.ac.kr/name	"TestContents"
http://demo.uos.ac.kr/sample.user002	http://demo.uos.ac.kr/name	"Kang"
http://demo.uos.ac.kr/reading11	http://demo.uos.ac.kr/name	"Page4"
http://demo.uos.ac.kr/reading12	http://demo.uos.ac.kr/name	"Page2"
http://demo.uos.ac.kr/reading13	http://demo.uos.ac.kr/name	"Page3"
http://demo.uos.ac.kr/reading17	http://demo.uos.ac.kr/name	"Page5"
http://demo.uos.ac.kr/sample.user003	http://demo.uos.ac.kr/name	"Bae"
http://demo.uos.ac.kr/sample.user004	http://demo.uos.ac.kr/name	"ol"
http://demo.uos.ac.kr/sample.user005	http://demo.uos.ac.kr/name	"Byun"
http://demo.uos.ac.kr/software/keris_lcms	http://demo.uos.ac.kr/name	"KERIS_LCMS"
http://demo.uos.ac.kr/event40	http://demo.uos.ac.kr/actor	http://demo.uos.ac.kr/software/testapplication
http://demo.uos.ac.kr/event31	http://demo.uos.ac.kr/actor	http://demo.uos.ac.kr/software/testapplication
http://demo.uos.ac.kr/event63	http://demo.uos.ac.kr/actor	http://demo.uos.ac.kr/software/testapplication
http://demo.uos.ac.kr/event85	http://demo.uos.ac.kr/actor	http://demo.uos.ac.kr/software/testapplication
http://demo.uos.ac.kr/event103	http://demo.uos.ac.kr/actor	http://demo.uos.ac.kr/software/testapplication
http://demo.uos.ac.kr/event104	http://demo.uos.ac.kr/actor	http://demo.uos.ac.kr/software/testapplication
http://demo.uos.ac.kr/event125	http://demo.uos.ac.kr/actor	http://demo.uos.ac.kr/software/testapplication
http://demo.uos.ac.kr/event150	http://demo.uos.ac.kr/actor	http://demo.uos.ac.kr/software/testapplication
http://demo.uos.ac.kr/event165	http://demo.uos.ac.kr/actor	http://demo.uos.ac.kr/software/testapplication
http://demo.uos.ac.kr/event189	http://demo.uos.ac.kr/actor	http://demo.uos.ac.kr/software/testapplication

#### [DEMO] 5. Dashboard showing engagement profile

#### Summary for [Son]

Subscription Period	Page Views	Total Session	Average Session	
7	74	982	35	
DAYS	PAGES	MIN	MIN	



Quiz



	Top 5 most viewed Page		Most act
1	Page8	1	Cho
2	Page9	2	Jung
3	Page11	3	Son

#### [DEMO] 5. Dashboard showing engagement profile



## Conclusion

- Need for Learning Analytics Interoperability
- Need for a Reference Model

**Explicit specification of the learning analytics systems!** 

## Future Work

- Standard data exchange model beyond information model
- Policy specification (in conjunction with ISO/IEC JTC1 SC36)
  - Privacy
  - Data governance
- Integration of the LOD of achievement standards
  - LOD for curriculum knowledge
- Open and extensible system

## Integration of curricula & contents

