Case Studies for xAPI

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1 Executive Summary

If you have questions on xAPI best practices or if you are curious why and how other organisations are implementing xAPI, you are in the right place. In this document you will find seven case studies. Although the case studies are examples of implementations in a K-12, Higher Education, and professional context, each case study can potentially add value for any sector because of the reasons for implementing xAPI. For example, the case study below (TorranceLearning Museum Project) has been designed for a K-12 context, however, providing personalised learning experiences based on how people interact with their environment and with learning materials can be quite valuable in other contexts as well. You only need to compare the TorranceLearning Museum Project example with the xAPI Internet of Things in Emergency Medical Training case study to see the similarities.

2 K-12

2.1 TorranceLearning Museum Project – Case Study

Providing personalised learning for K12 students based on the way they move around and on their actual interactions with learning materials

The Hands-On Museum is a children's STEaM (Science, Technology, Engineering, Art, Maths) museum located in Ann Arbor, Michigan, USA. The Museum wanted to accomplish two goals: providing a richer experience for students by slowing them down long enough to engage and interact meaningfully with an exhibit. To accomplish this, the museum needed to track which students were at which exhibits and determine their knowledge through questions that students had to answer on tablets that were located at an exhibit. Teachers had real-time access to this data; that is how the students moved around between exhibits and the quiz results associated with each exhibit.

The museum is already set up as an interactive space for young students, but what xAPI brings is the prospect of tracking just how those interactions take place. The case study generally involved around 3rd-grade students. The museum used RFID tags embedded into nametags to log students into the tablet that is associated with an exhibit. The tags allow the tablet beside the exhibit to recognise them and greet them by name as they approach - a basic form of personalisation. The xAPI-enabled system can then track free-form text entry and multiple interactions with the screen and collate and display that information using a dashboard. The system records activity streams (i.e. the interactions of every kid with the tablet; every action; every object) but can also provide information on specific kids and specific exhibits. This all happens in real time and the teacher can see it as the student walks through the museum. Teachers use this data to find out how the students interact with each exhibit and what they know through the interactions. The next step for the project is to collect enough data so that teachers can analyse it and make decisions based on the data; e.g., adapting their own teaching materials to cover identified knowledge gaps. They may also want to adapt their learning strategies to make better use of the museum based on the evidence of how their students approached the exhibits. This opens up the potential for real personalisation of learning based on a student's level (e.g. school grade) and his or her specific needs (e.g., requires a general overview of a particular subject or needs more advanced learning because this has been the focus of a teacher's instruction).

The technical solution combined RFID or Radio Frequency ID technology (though future iterations will use beacon technology as a more reliable means of tracking students on the move), tablets, and xAPI. The museum used RFID tags embedded into nametag lanyards to log students into each exhibit. As the students come into range of a wall-mounted antenna, a tablet computer mounted nearby greets them by name and engages them in a short series of questions and explorations with the exhibit.

Data from each student activity is sent back to the LRS (Learning Record Store) immediately after the students complete the interaction, or after they "log out" by leaving the area. Teachers and museum staff can then access a dashboard showing an activity stream and some simple data visualisations by student and by exhibit. A search function allows teachers to search for specific text strings found in either the xAPI statements or in the text responses typed in by students.

When students approach the exhibit, the antenna picks up on their name badges and the tablet opens up the appropriate grade level content. One of the advantages of the xAPI over SCORM is that it can record the same activity data for multiple learners at once. Each time a question is answered or a response given on the tablet, an xAPI statement is formed.

The data is sent to a LearnShare LRS for storage. A separate dashboard page requests these statements from the LRS to create the nearly-real-time report. A key benefit of this application is that the xAPI statements produce an easily readable activity stream in the form of statements.

Whereas in SCORM, a user must generally be logged into a system to record their individual progress and interaction, the xAPI allows the recording of the activity of anonymous users in any location.

In future phases, the xAPI will allow the recording of objective data from the exhibits themselves.

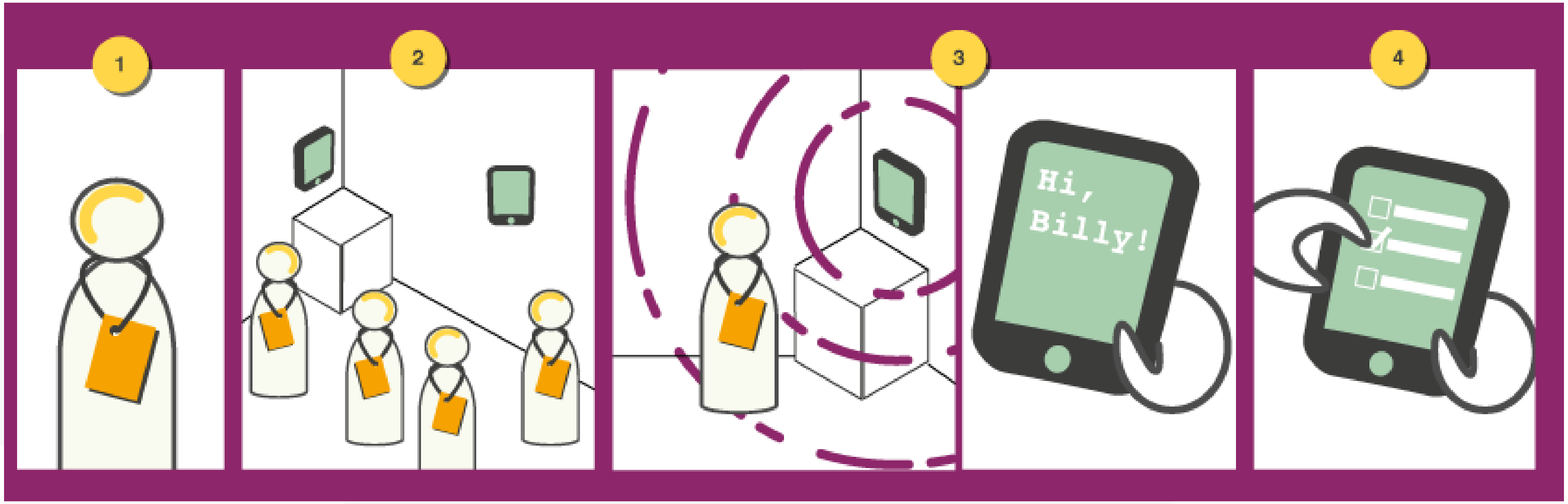

Figure 1 Torrance Learning - Illustration of Learner Experience

1. Each student gets a nametag. Each nametag has a RFID tag embedded in it.
2. All the students explore the museum. There are RFID readers within the media devices.
3. The tags allow a media device alongside an exhibit to recognise them. The media device queries the LRS, it then greets them by name as they approach. The media device also notes the student's activities and stores them in the LRS.
4. The device is used to assess the student's knowledge. The student answers questions associated with the exhibit.

More information

- Case Study: Ann Arbor Hands-On Museum's Personalized Interactive Exhibits
- Adventures in the xAPI: The Ann Arbor Hands-on Museum Project
- Megan Torrance on Agile Elearning (Video)

2.2 City & Guilds TechBac® - Case Study

Providing students with a holistic curriculum that prepares them for working in 'the real-world' in an authentic manner.

City & Guilds TechBac® is a programme designed to give 14- to 19-year-olds a learning path towards an apprenticeship, higher education or employment. It gives them the technical and workplace skills to enter the real world of work to 'make our students the most employable they can be'. Using a real-work environment; and real work scenarios, training focuses on skills-based qualifications and not just theory. It is specifically designed to help students to develop the skills employers say they need.

TechBac® uses Skills Zone, a portal that brings together workplace skills training with a mentoring programme, business challenges, and an online CV Builder. These different systems are linked together using xAPI. Using this approach, City & Guilds are able to store a student's progress in a Learning Record Store (LRS), unifying all of the systems into a single record of progress and achievement.

Through the LRS they can display data to students and tutors, as well as reporting back usage to City & Guilds for analysis. Students can visualise their progress on a dashboard called the City & Guilds Skills Wheel. Students can then export this data to their own tailored CV, customising the information that they would like to present back to potential employers.

The video below explains how the workplace Skills Portal operates with its emphasis on mobile and social learning to enhance more traditional course-based learning.

The benefits for students and tutors are that xAPI allows them to connect their existing learning systems so that students receive a more complete and seamless learning experience. The introduction of the LRS provides for each student to have his or her own unique learning record. This can be updated as new learning occurs and is potentially portable and transferable as they continue to learn beyond the K-12 sector and seek employment. The skills wheel (see illustration below) not only shows them where they are but also where they could or should be in their training and competencies. The overview provided by the analytics coming via xAPI to the tutors allows them to judge progress, intervene where progress is stalled or insufficient, not just with individual students but also for an entire group. The bigger picture afforded by the use of xAPI can lead to better mentoring as the learners proceed through their training.

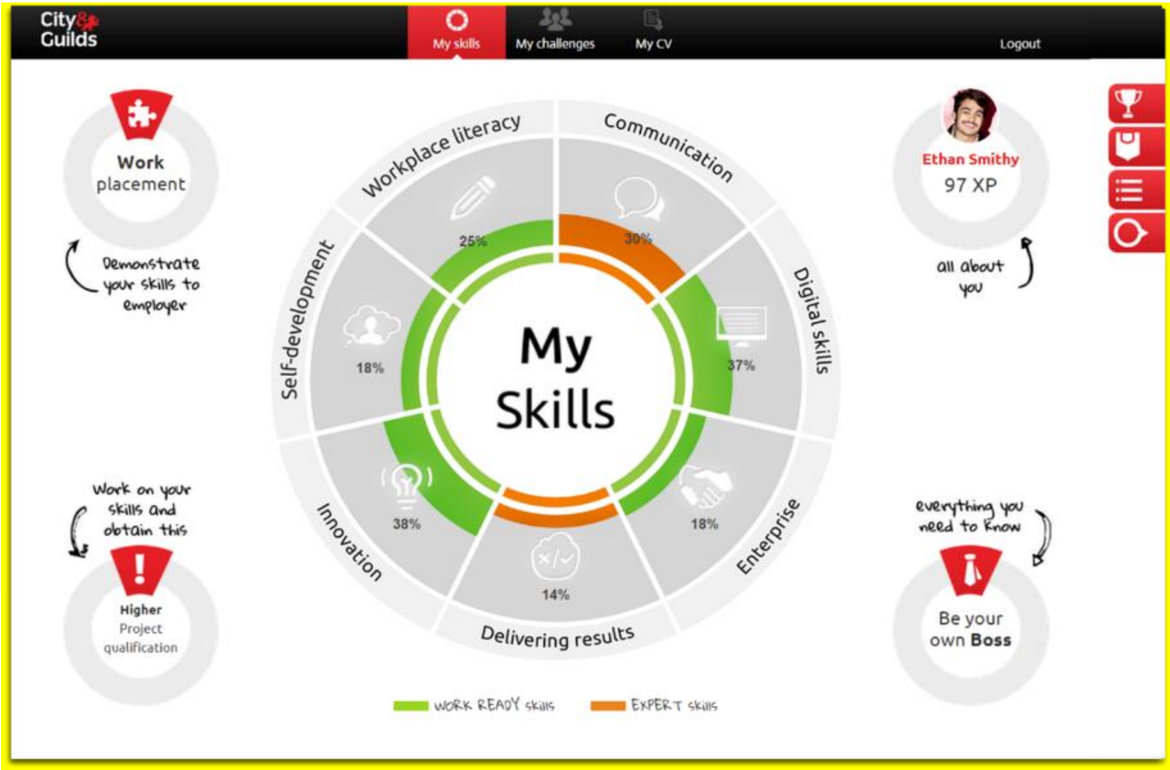

Figure 2 Example of the Skills Wheel

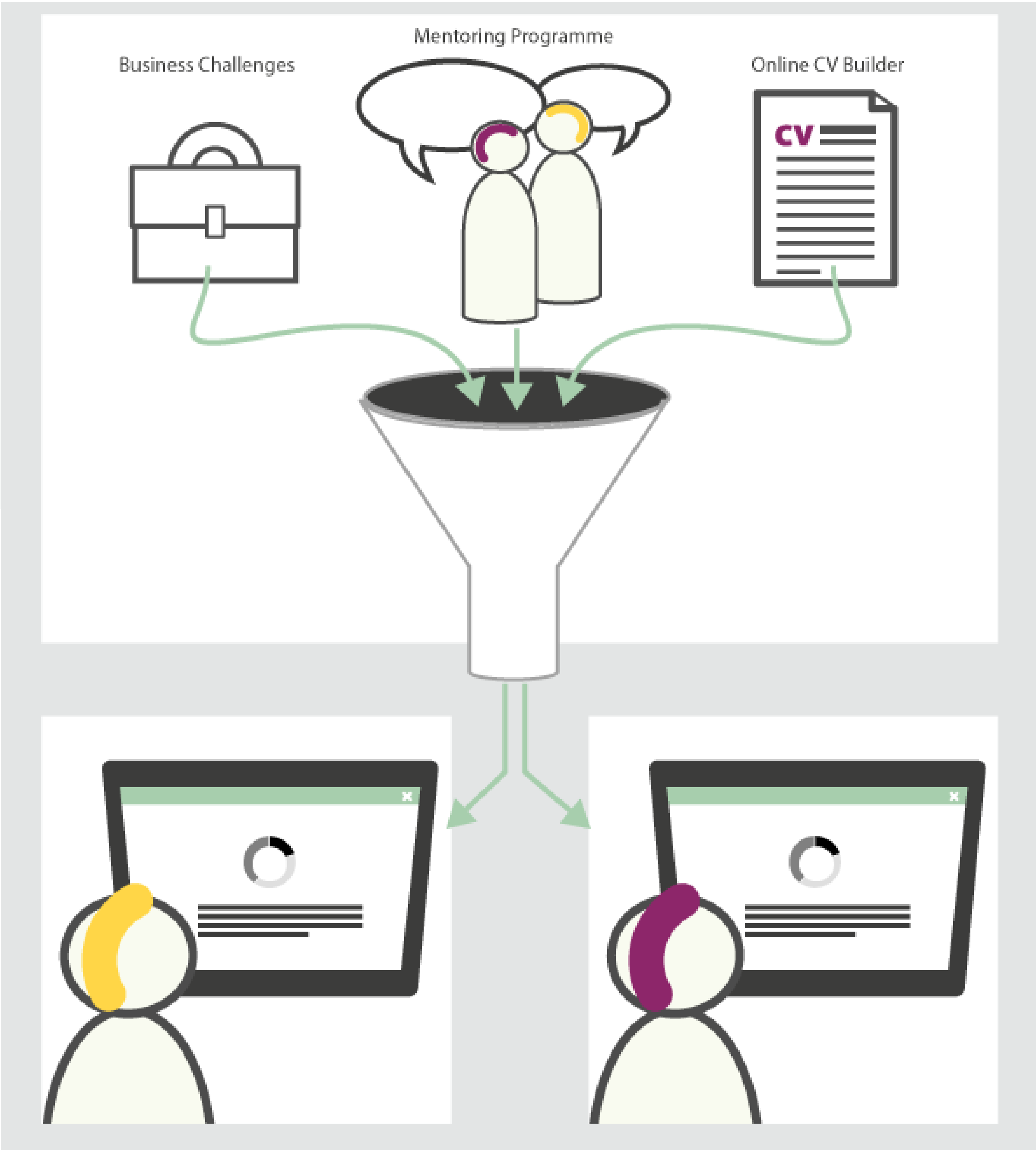

Figure 3 City & Guilds TechBac® - Illustration of Learner and Tutors Experience

More information

- HT2 Labs City & Guilds TechBac® Case Study
- City & Guilds TechBac
- City & Guilds TechBac Skills Zone (Video)

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2.3 Emerging Trends

- Adapt learning experience e.g., based on the behaviours and interactions of learners.
- Improve learning experiences and effectiveness through using learning analytics (using xAPI statements).
- Creating portable learning records that move with the student or employee
- Personalisation of learning to meet a learner's or group of learners needs identified via xAPI.
- Using Learning Record Stores to replace dependence on Learning platforms and allowing records to be more easily shared and transferred
- Recognising the benefits of xAPI statements in recording and structuring data that can be readily analysed and synthesised and provide a clearer understanding of where students are in the learning process.
- Recording and storing data in a LRS from mobile devices
- Analysing the learning data to allow visualisation in dashboard format to check progress and attainment.

3 Higher Education

3.1 ECO Project – Case Study

Improving learner performance and engagement in MOOCs through timely intervention.

ECO focuses on expanding on the most successful experiences with MOOCs in Europe. The ECO project created a Massive Open Online Courses (MOOCs) platform based on individual platforms and resources provided by the ECO project partners.

A MOOC:

- Includes a variety of learners with different, heterogeneous backgrounds, making it difficult to provide accurate and valid results. The learning goals and objectives may vary amongst learners (e.g. intention to fully complete a MOOC versus only being interested in particular parts or just wanting to explore).
- Includes instructors' or facilitators' participation is usually limited to important announcements or a 'crisis' situation.
- Is also about learning through connecting and interacting with others, hence there is a need for social learning analytics as well.

In addition, important concepts such as progress, performance, mastery, participation, and dropout need to be redefined in the light of a MOOC's requirements. For example, progress is defined as movement towards the achievement of a goal, taking optional and compulsory activities into account. Progress also needs to be measured against individual's learning goals.

Another critical element to consider in a MOOC is the fact that there are various user types. The ECO project identified four different ones:

- *Completing:* Those who visit every week, read most of the activities, and complete most of the assessments and basically follow the course as designed aiming for certificate.
- *Auditing:* Those who visit every week, read more than average of the activity pages and infrequently complete assessments. In the questionnaire, these learners have indicated not to aim at a certificate.
- *Exploring:* Those who watch lectures for only one or two periods of the measurement interval or do only one or two modules. These learners have indicated to follow the MOOC out of interest.
- *Disengaging:* Those who completed some assessments in the beginning but then decrease

The ECO project is comprised of a set of learning platforms that have their own logging and monitoring systems.

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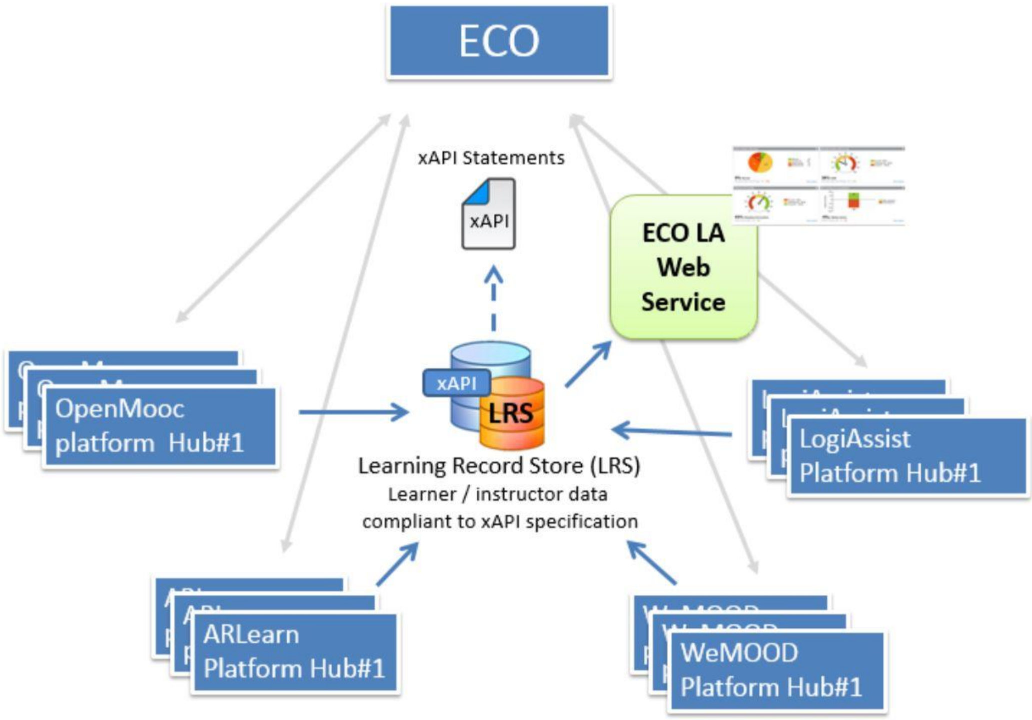

Figure 4 ECO proposal for architecture

The ECO project entails a gain for learners and instructors alike. A more accurate understanding of the large learner base allows for better categorisation. Based on that categorisation of user type, instructors can plan swifter or just-in-time interventions to assist those learners who are struggling. They can also plan or design their instruction and learning content to address the needs of the learner types described by the learning analytics. A better awareness of and familiarity with the learning audience (which can be vast for MOOCs) will lead to more targeted learning design: e.g. how to gr material for a learner who is intent on completing a course as opposed to one who is just exploring; or whether and how to channel more effort into encouraging a higher completion rate.

The importance of using the xAPI specification to log learners' behaviour in the platforms is that it guarantees interoperability between the various ECO platforms and with external platforms, because actions are registered in a standardised format.

Event	xAPI verb	xAPI object/activity	context	result
Learners access wiki	accessed			
Learner access wiki page	accessed			
Learner creates wiki page	authored			
Learner edits wiki page	updated			
Learner access game	accessed	game		
Learner submits game	submitted	game		
Learner updates personal profile	updated	page	profile	
Learner views another user's profile	viewed	page	profile Agent	
Learner adds contact to list	appended			
Learner removes contact from list	removed			
Learner requested friend	requested friend			

Figure 5 Examples of events that can be tracked through xAPI statements

The case study begins with the premise that providing learning analytics tcan give valuable support to learners, instructors and course designers by providing key indicators of performance, progress and achievement. These can be visualised by the use of dashboards based on the data collected and the way it is structured. The dashboards can provide individual learners' details of their own performance, but also show aggregated data to provide instructors with a comparative or summary view of a group of learners.

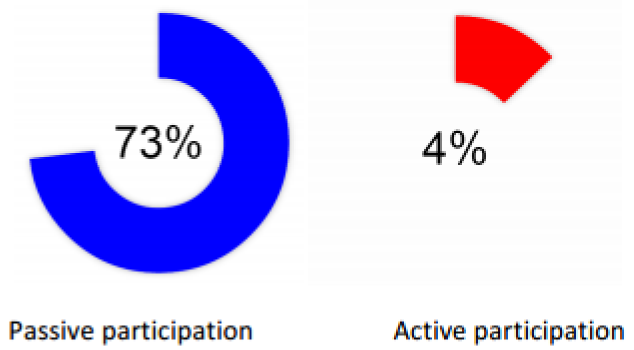

Figure 6 Percentage of participation in an activity forum) using donut charts

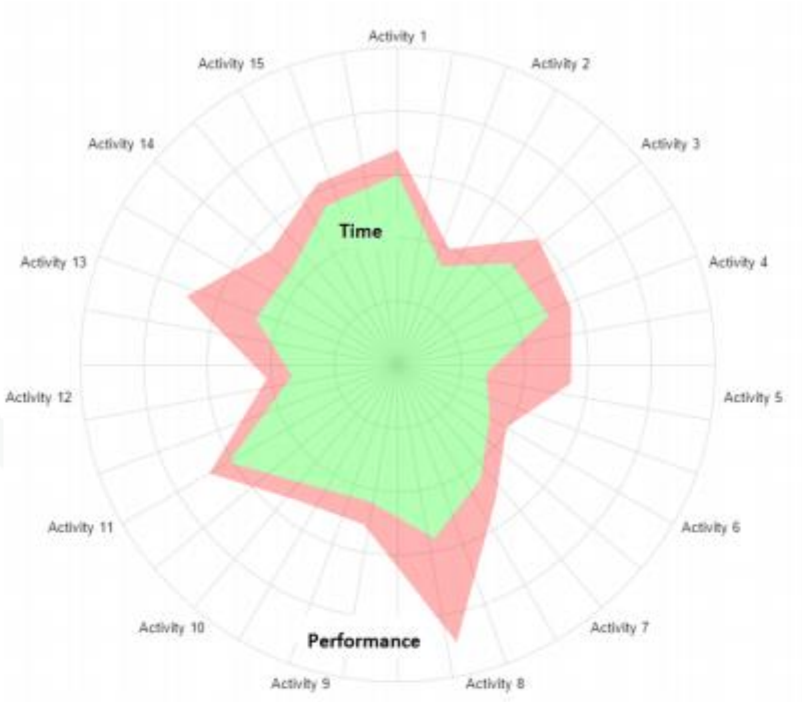

Figure 7 Radar chart showing the correlation between time per resource/activity and performance in the tasks

ECO laid out metrics and indicators for learners, based on learning and social goals (see for example page 40-44 of the ECO report). They also did this for instructors and course designers who need additional indicators as compared to learners. Instructors need to be able to reflect on and predict the quality of learners' processes and progress while course designers need to be informed by the effectiveness and efficiency of their design and identify how their design affects the learner's behaviour.

In addition one needs to consider how these learning analytics indicators can be best shown to learners and/or instructors through the use of visual analytics and, for example dashboards. In this context, it is also important to distinguish between 'checkpoint' analytics and 'process' analytics. The first category refers to analytics that determine whether learners have accessed relevant resources and the second is needed to get some insight in learning processes (e.g. information processing and knowledge application).

Another step in the process is to identify the data that needs to be gathered for the metrics and indicators.

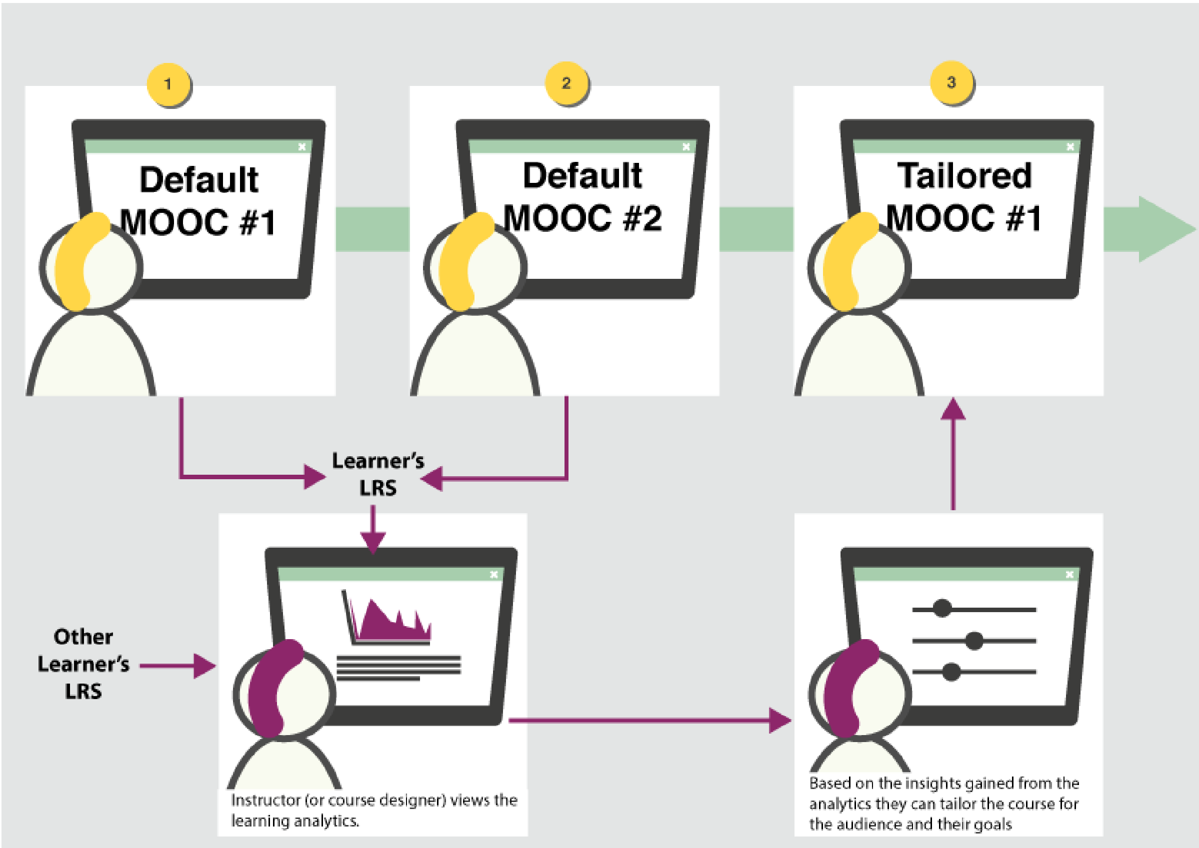

Figure 8 Eco Project - Illustration of Learner Experience

More information

- ECO Project Website
- ECO Learning Analytics Requirements and Metrics Report

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3.2 Nottingham Trent University Using Jisc- Case Study

Jisc is a UK higher education, further education and skills sectors' not-for-profit organisation for digital services and solutions. This case study focuses on a study of learning analytics derived from the digital footprint left by learners in a range of higher-level institutions in the US, the UK and Australia, and predicated on the notion that improved analytics has the potential to improve learners' learning experiences at university.

The Jisc implementation of xAPI provides a more comprehensive, detailed record of learner activity on digital devices. The information is provided to both learners and instructors so they can both make more informed learning choices.

Nottingham Trent University in the UK introduced a learning analytics initiatives to roll out a Learner Dashboard (see sample screens below). The idea behind the dashboard was to facilitate dialogue between learners, their personal tutors and support staff. It had seen widespread uptake and lead to positive impacts on learner engagement, plus a change in the organisation's culture towards a more data-driven approach.

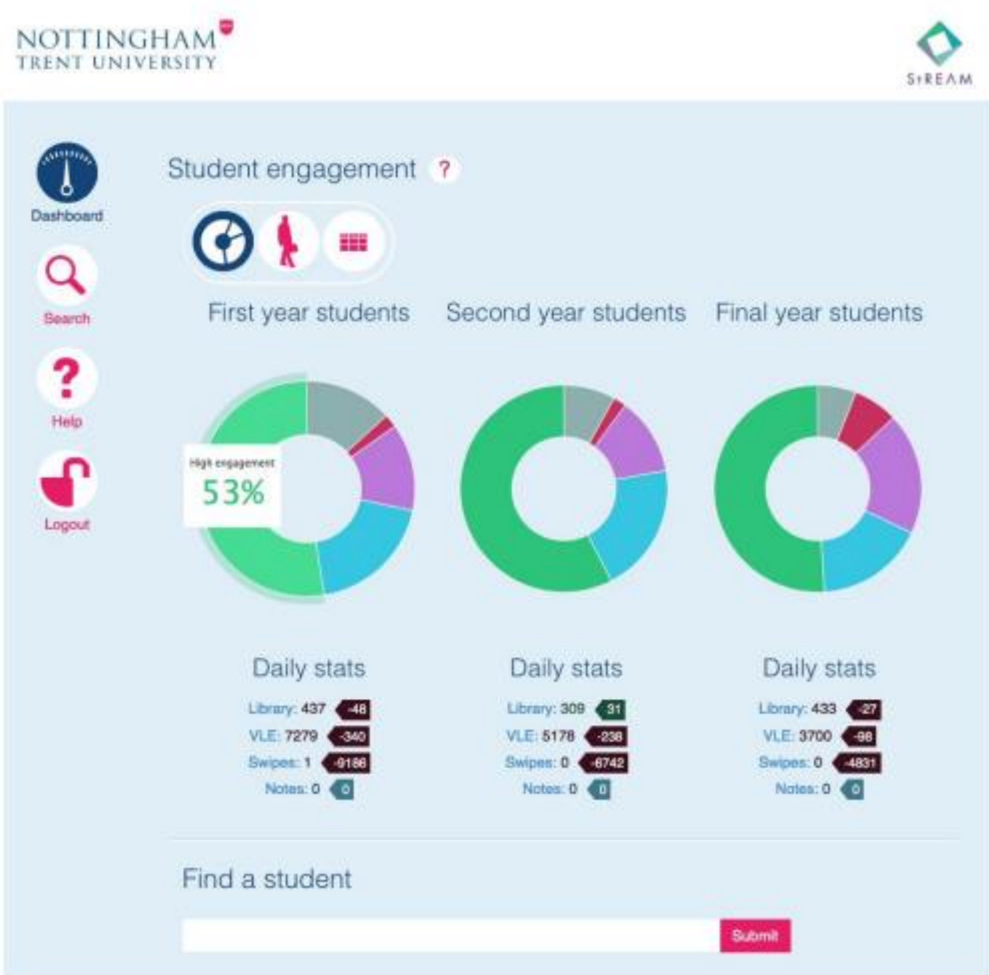
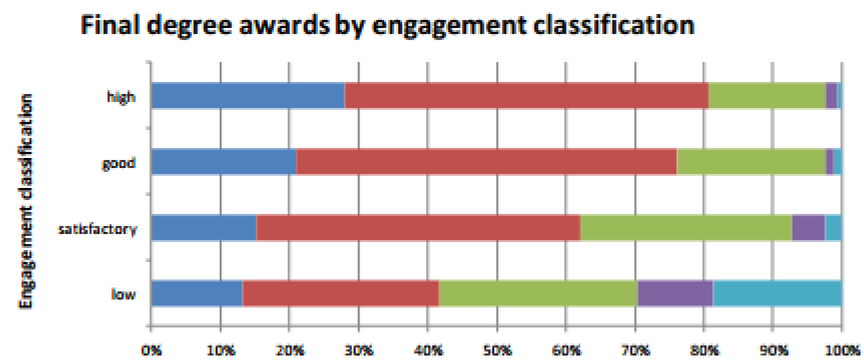


Figure 9 Student Dashboard, staff log in view

Figure 10 Week by week engagement score (for the same student as previous figure) compared with the course mean .This gives a more responsive view and students can see dramatic changes to their engagement within a week.



	low	satisfactory	good	high
1st Class Honours	13.2%	15.2%	20.9%	28.0%
2nd Class Honours-1st Division	28.6%	47.0%	55.2%	52.5%
2nd Class Honours-2nd Division	28.6%	30.5%	21.5%	17.0%
3rd Class Honours	11.0%	4.9%	1.4%	1.8%
Other - Ordinary Degree	18.7%	2.4%	1.1%	0.6%

Figure 11 The association between average engagement and final degree classification.

Learning design can be better focused where there is a better understanding of the learners' actual, rather than merely perceived needs. The access to greater information in easily-presentable formats (e.g. dashboards) can signal to both learners and tutors where change or intervention is required. It allows for a more nuanced approach to learning design and activity to the mutual benefit of learners and tutors. Also greater knowledge of learner engagement (provided by the xAPI data) and an understanding of its predictive of success (greater engagement tends to lead to greater success illustrated in Table 2 from Nottingham Trent University) leads to more effective intervention and support from tutors to improve learner engagement.

The evidence or data collected leads to the conclusion that predictive models used by learning analytics systems produce effective learning interventions for learners and that more data-driven approach would lead to further benefits in providing higher education.

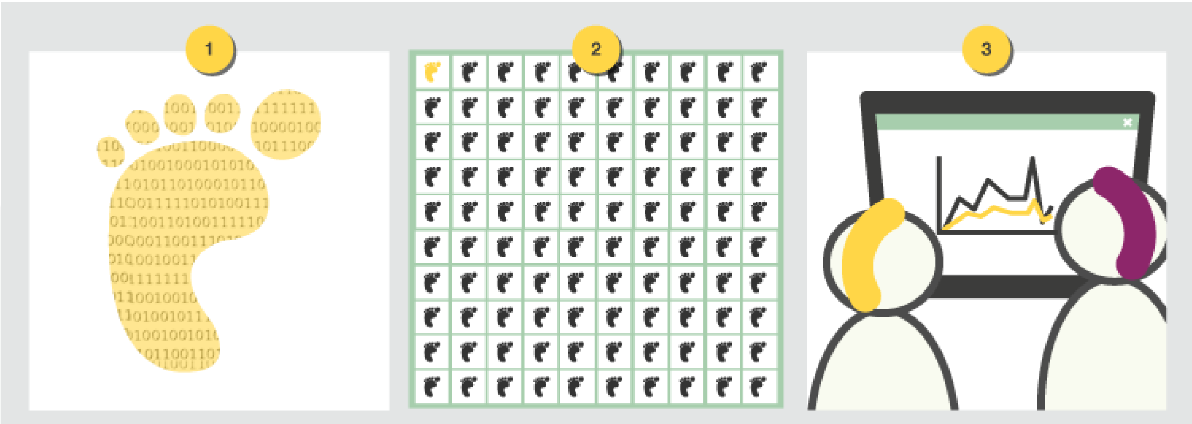


Figure 12 Nottingham Trent - Illustration of Learner Experience

1. A learner's digital footprint is tracked.
2. This footprint can be compared and contrasted to the digital footprint of all learners within the system.
3. Dialogue between learners, their personal tutors and support staff can occur based on data.

More information

- http://project.ecolearning.eu/
- http://project.ecolearning.eu/wp-content/uploads/2016/03/ECO_D2.5_Learning_analytics_requirements_vFINAL.pdf

3.3 Emerging Trends

- Increasing the adaptation and personalisation of learning
    - Enabling more focused learner support
    - Identifying at-risk learners through learning analytics
    - Using xAPI allows for earlier, corrective intervention for struggling or underperforming learners
    - Giving learners better feedback to assess their own performance and consider their own learning priorities
- Improving course design based on evidence gathered from broader range of learner activity or digital footprint (e.g. informal learning)
- Recognising the increased role and significance of informal and social learning
- Structuring data to allow simple but compelling visualisation to monitor performance, progress and attainment
- Structuring that data in line with expectations of achievement and attainment and to record certain milestones.
- Enabling interoperability via xAPI of learning platforms/systems that previously couldn't connect.

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4 Learning for Professionals

4.1 RISC – Case Study

Personalising learning content through PDF annotations.

This case study outlines an xAPI solution designed for a client by the RISC Learning Management Systems company for recording annotations made on textbooks stored on cloud (to replace previous distribution of books on pdf via USB keys). The solution records data (i.e. the annotations made) and removes the need for distribution of electronic materials via USB also mitigating the risk of viruses (threat from use of USB keys).

The image below shows an example of what the annotator application can do.

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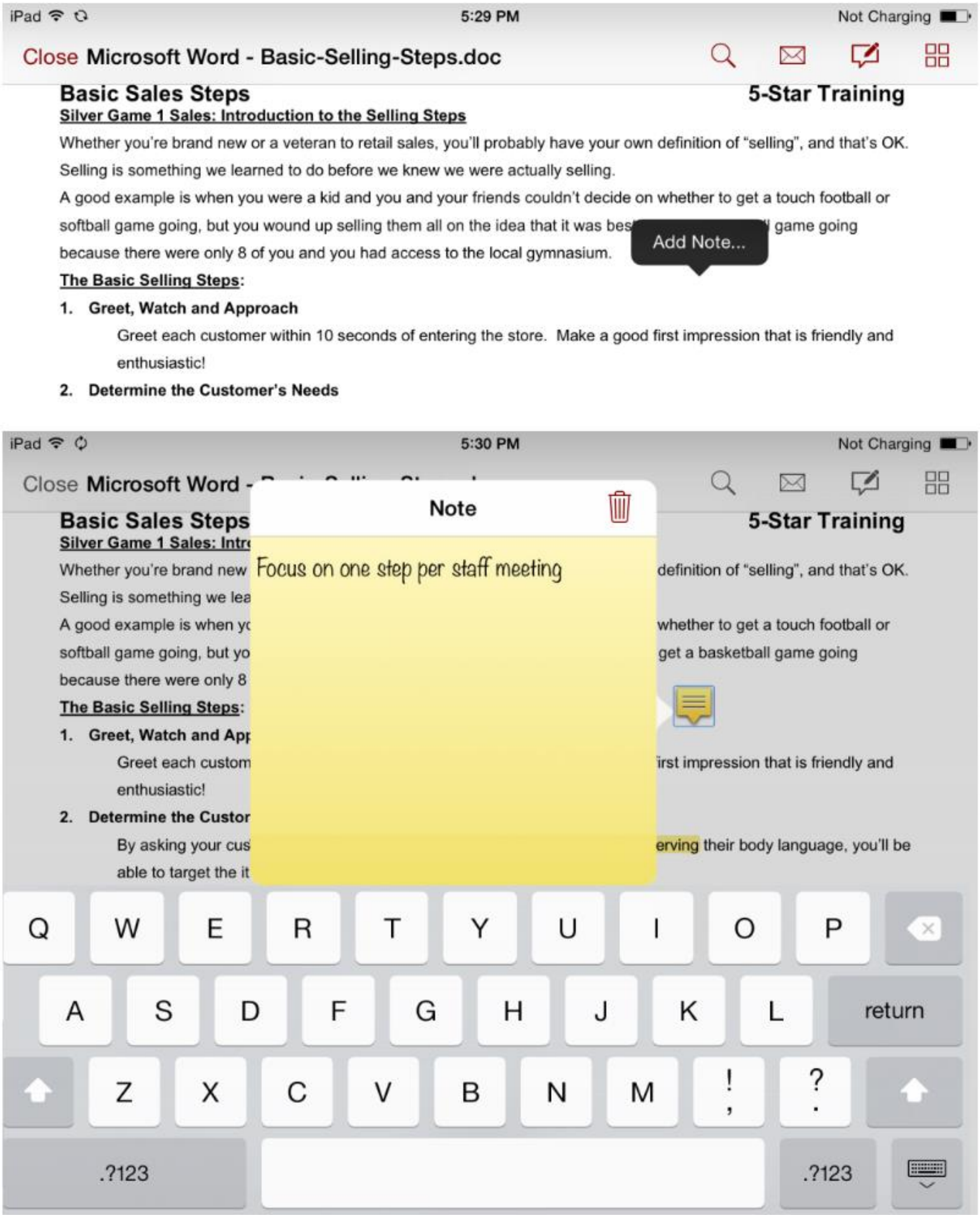

Figure 13 Annotator Application

The annotations employees make can be accurately captured, stored, and analysed. Once the annotations have been catalogued and analysed, the content can be amended, personalised and

tailored to employees' needs. This 'feedback loop' has the potential to make training (or any) documents more relevant by addressing the expressed needs of the employees.

It would be valuable for RISC to track annotations made. Knowing which pages received the most annotations and tracking the most common annotations the customer could amend and improve their documents, better meeting their audience's needs and answering the audience's commonest questions.

From a technical point of view, RISC considered how an LRS could be used to track the annotations made by users by using a PDF Annotator application with xAPI capability. This meant:

1. Documents could be stored in the cloud
2. The only access to the documents would be through a Learning Management System called VTA Learner. Students would therefore no longer have direct access to the PDF files, removing the need to distribute the PDFs via USB keys with the risk of viruses.
3. Annotations would be stored in the cloud
4. Student annotations would be stored in the VTA LRS. With this approach a user could annotate documents in the cloud using a classroom computer, but still access their annotations back at their own desk.
5. Both Browser and iPad versions.
6. The LRS would provide reporting on learner activity.
7. Reporting capabilities could be provided to help improve documents based on user annotations.

The company is enhancing the xAPI-enabled annotator to include new annotation types and an analytics dashboard

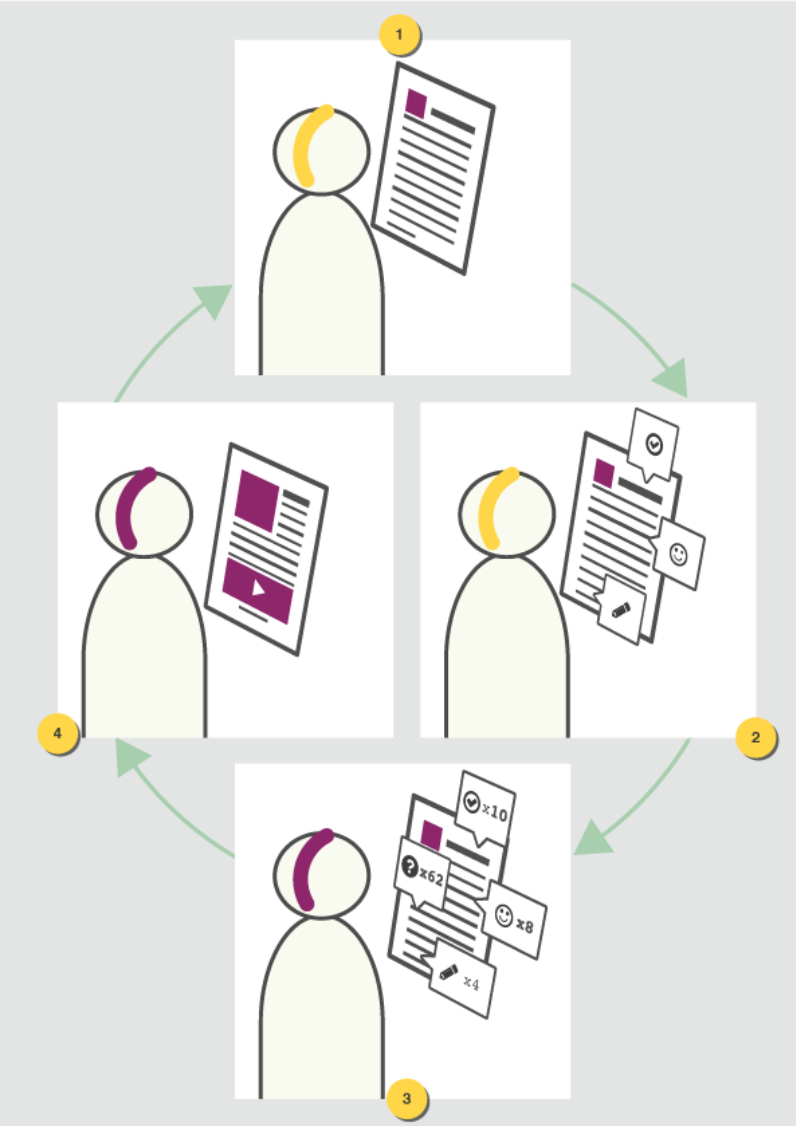

Figure 14 RISC - Illustration of Learner Experience

1. The user accesses the document on a media device which is remotely served on an LMS.
2. The user's activities and annotations within the document are sent to and stored in the LMS.
3. The administrator, such as a Learning Designer, can see the aggregated activities and annotations of many users.
4. The administrator can then update the document so that the content is more appropriate for the body of users. The updated document is synced to replace the original one.

More information

- http://risc-inc.com/pdf-annotation-cloud-real-world-xapi-application/

4.2 xAPI and IoT (Internet of Things) in Emergency Medical Training – Case Study

Data collection through authentic simulations in order to support performance improvement and patient outcomes.

This study covers medical training simulation involving Emergency Medical Technicians (EMTs) from the Fairfax Fire and Rescue Academy in Virginia, USA. Specifically it focuses on the use of xAPI to record and collect data in real time during the simulation of a medical emergency. The data is collected using devices such as Bluetooth proximity beacons, activity sensors, and ultra-small microcomputers deployed on EMTs, firefighters, victims, equipment, and an ambulance. The data is sent to an xAPI Learning Record Store (LRS) in the Cloud where it is visualized in real time and made accessible to the team of nurses and doctors at the hospital, all of whom are also wearing beacons and whose preparations are being recorded live to the same LRS.

Training simulations are generally either computer-based or require human observation of activities. xAPI offers the potential of a combination of the two by collecting digital data from an authentic simulation.

The main purpose of this simulation was to measure, register and assess situational awareness (i.e. knowing what's going on around you), team coordination, leadership, and performance under stress in realistic environment with a team of participants.

The effectiveness of simulations is often limited by attention, memory, and knowledge of the participants and the facilitators conducting debrief. The data collected in this simulation was primarily proximity data (recording medical technicians' proximity to the manikin used as a stand-in for a real patient) and the medical interventions of the EMTs (e.g. monitoring patient's heart and blood pressure or administering an intravenous [IV] line). The data from the medical interventions was recorded manually, but was also transmitted to the LRS along with the automatically-collected proximity data. The proximity devices transmitted over 14,000 xAPI statements in the course of the hour-long simulation. The statements used the verb 'detected' to indicate a technician's proximity to the 'patient'.

The proximity data provided an extremely accurate picture of when and where each technician came into contact with the 'patient' and the length of time he or she remained in contact. The data can be visualised as illustrated here:

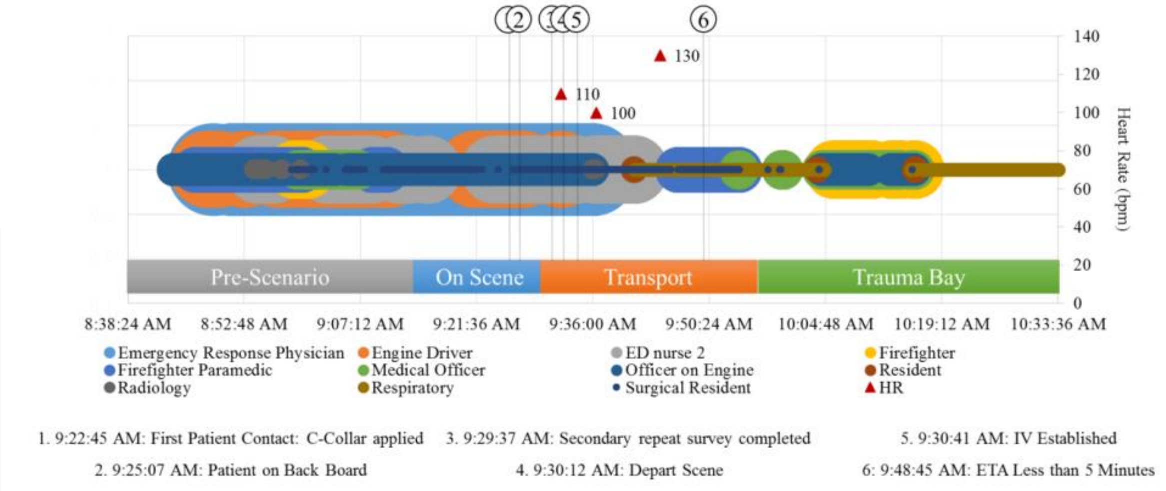

Figure 15 Proximity by Role, Time, Event, and Space

This objective picture of a technician's activity can be compared with his or her own recollection of events and used to debrief to improve awareness and performance. The quality of the data gathered will inform not only the debrief after the event, but also will be used to enhance medical-emergency training to improve the outcomes of actual patients. The next step in the project is to refine statements to provide more detailed, semantically-richer statements and validate the data against real practice with a view to improving team training. There is also a plan is to expand the potential for data collection with the addition of wearables, medical device integrations, and more complex sensor systems, so that trainers and trainees will gain a 360-degree view into what is actually happening during a complex multi-team operation.

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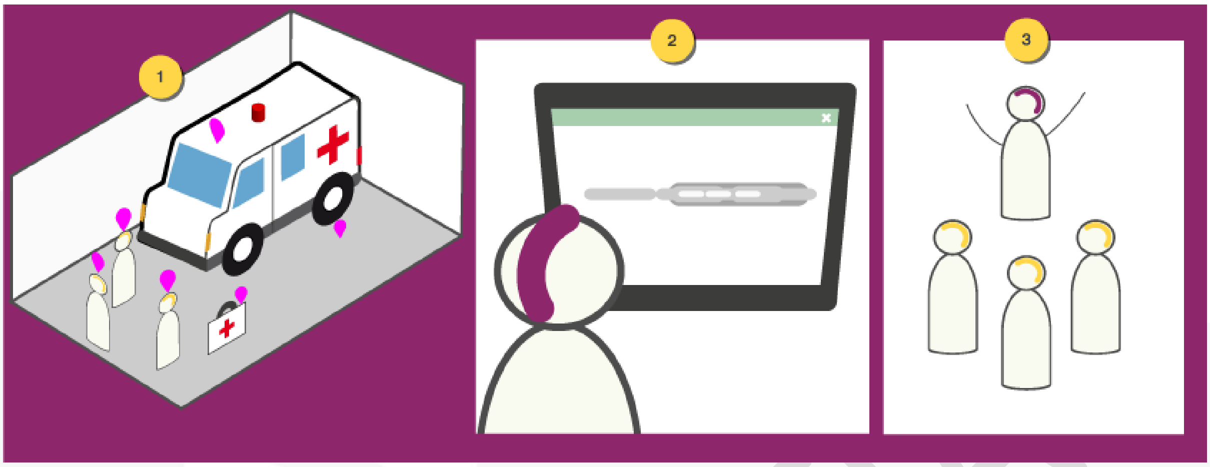


Figure 16 Emergency Medical Training – Case Study Illustration of Learner Experience

1. During a medical training simulation beacons on EMTs, firefighters, victims, equipment, and an ambulance record data.
2. The data is sent to an xAPI Learning Record Store (LRS) in the cloud where it is visualised in real time
3. The data can be analysed after the simulation to support performance improvement in order to improve patient outcomes in medical emergencies.

More information

- http://www.tryxapi.com/case-study/iot.html
- https://www.us-ignite.org/globalcityteams/actioncluster/NSkmt5PEY5iTYgweMCPvRd/
- https://cehd.gmu.edu/news/stories/brendan-bannan-researches-emergency-response-with-fairfax-accident-simulation
- https://adlnet.gov/adl-assets/uploads/2015/12/Embedding_Cyber-Physical_Systems_for_Assessing_Performance_in_Training_Situations_Gallagher.pdf

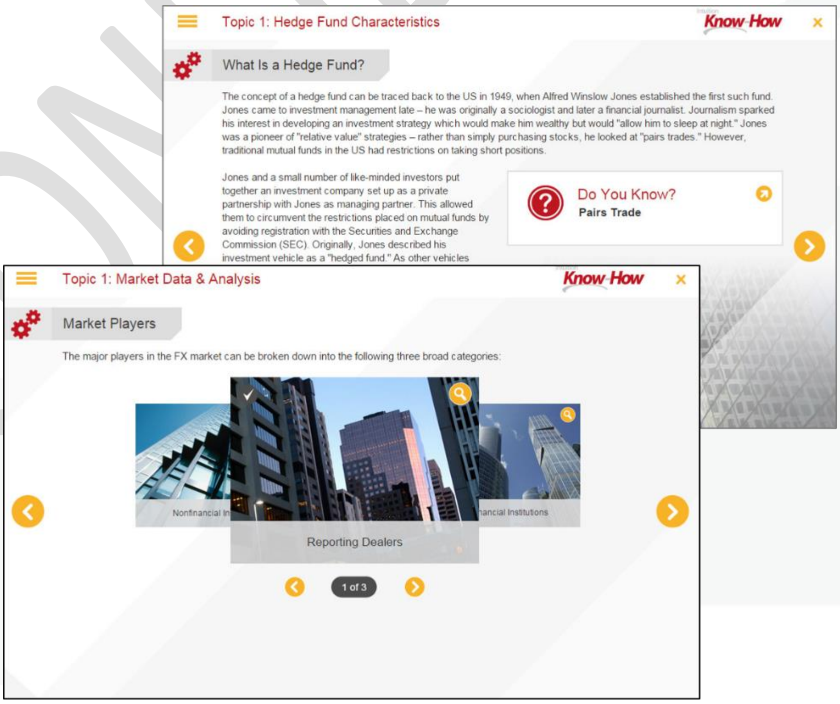
4.3 Intuition LMS: SCORM vs xAPI – Case Study

1. *Adapting learning content to better meet learners' needs and*
2. *Learning from an initial xAPI implementation to be better prepared for future custom implementations*

Intuition is a leading global knowledge management solutions company. Part of its portfolio involves working with its clients to design and deliver learning programs as well as providing knowledge management technologies, for example LMS and mobile learning.

This case study outlines an xAPI implementation in Intuition's LMS platform which hosts an off-the-shelf content library. Although the LMS still supports SCORM, the current version of the platform was built on xAPI. The reason why Intuition decided to move to xAPI instead of remaining with just SCORM was firstly based on trends, which suggested xAPI as the learning standard that would have more longevity. Secondly, it was the right time to make the move because they were updating their platform. Keeping SCORM and building xAPI on top of the platform was a cost-effective way of implementing xAPI.

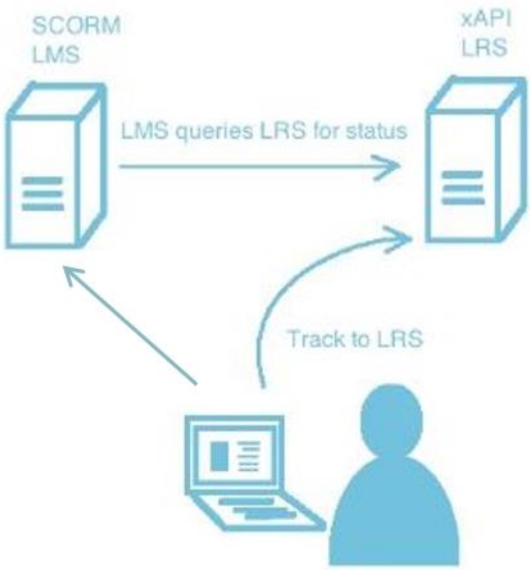
In addition to the practical reasons for implementing xAPI, Intuition's clients have been requesting better quality reporting analytics on the learning content. For example, they would like to gain insight in learner engagement and learning effectiveness (e.g., knowledge level). Analytics can help to determine the quality of the content so that it can be adjusted where needed. This could be required when learners are struggling with certain content or when it turns out to be too easy in relation to the learning or performance objective that needs to be achieved.



Screenshot of Intuition's Know How Library

Currently, the platform works as follows:

- When running xAPI content, it gets tracked to the LRS only
- When running SCORM content, it gets mapped into xAPI statements and tracked to the LRS. In addition, in order to support legacy SCORM based reports, the SCORM based tracking gets stored to the SCORM LMS database.



Source edited from here

When Intuition implemented xAPI in their platform LMS, they encountered various challenges. The table below outlines the challenges as well as how Intuition solved them.

Challenge	Intuition's Solution
The xAPI standards are not built to support offline access; for example when a learner has a document running on their device and is not connected to the Internet, the statements have nowhere to go.	Built a 'mini LRS' within the applications on the device so that, if a learner was running offline content, the statements were queued up. When the learner gets back online, the statements are sent back up to the server (the main LRS).
Lack of other xAPI implementations and reference materials, for example because the standard is still in a relative early phase, there were no libraries with code references that Intuition could use.	Everything had to be built from scratch.
Identifying xAPI content and examples to test the platform. All the content at the time was SCORM-based content.	Used some content that was available on the xAPI website.

Intuition is currently testing the xAPI implementation in their LMS platform, analysing the off-the-shelf library content. They also have plans to take the implementation a step further, for example by

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collaborating with learning experts to determine what data should be captured from the content library and why. Furthermore, Intuition recognised that innovative learning experience ecosystems blur the lines between formal and informal learning experiences and focus on personalised learning. Therefore, Intuition is working with companies such as Degreed, Edcast and Pathgather to make its content library available through their platforms.

More information

- http://www.intuition.com/

4.4 Emerging Trends

- Capturing learner feedback outside of a traditional formal learning environments (e.g. LMS or face-to-face) using a variety of systems and tools (e.g. data from internet use) and via various devices (including mobile phones, apps, antennae, and beacons), for example adapting and personalising learning content based on enhanced data collection and analysis through PDF annotations.
- Improving the learning experience and enhancing performance by tracking behaviour through mobile devices in authentic simulations, that require a complex network of systems and devices
- Adding a visualisation layer to enable better and quick understanding of performance and other metrics (note that this is an additional step to implementing xAPI).
- Starting with the 'low hanging fruit' (adding xAPI on top of SCORM) to experiment and test and to get ready for customers that require bespoke xAPI implementations.

5 Appendix

5.1 Table of Figures

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