Institute of Technology Tallaght, Dublin
Department of Computing

Bachelor of Science in I.T. Management

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Format:	Individual

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Table of Contents

List of Figures

Section 1: Initial Research

Abstract

During my third-year work placement with SAP in Citywest, I worked closely with their cloud product SuccessFactors. SuccessFactors is a Human Capital Management suite of core HR solutions. It contains a number of 'modules' each which serve a different function to help improve a business. The module I was assigned to specialise in during my time there was the Learning module. On a daily basis, I was completing e-Learning trainings and lessons to upskill and familiarise myself with SAP's own Learning Management System, along with how to administer this system and customise it adhering to customer's needs and requirements. I completed 5 months of trainings in order to complete the first set of certifications for the Learning Module, called SFX certifications. However, to be able to work closely with customers it is required to complete the Academy training for your module. Although, I was not allowed to do the Academy certification for the Learning module due to the fact I was returning to college, I still completed the advanced course on SAP's e-learning module before my internship ended. I found the area of e-Learning very enjoyable to be working in for SAP and, I know that their Learning system is only one out of hundreds available today. I was only exposed to SAP's e-Learning product and I never got the opportunity to explore the area of online learning in a broader perspective. That is why I chose to base my 4th year project on the subject area of e-Learning. I believe it will be interesting and beneficial for me to further explore and investigate this area and learn more about it.

E-Learning

E-Learning Introduction

The phrase "e-Learning" was originally coined in 1999 at the Computer-Based-Training (CBT) seminar in Los Angeles. However, the area of online, or virtual, learning has existed since the early 1990's. When the idea of this virtual learning was announced, at first it was met with a lot of bad press and resistance. Many people rejected the idea as they believed that bringing in computer technology to the classroom would completely eradicate the human element of teaching that some learners desperately require. However, as time progressed, many schools took advantage of the internet and began to implement these Learning Management Systems. This allowed schools and colleges to bring education to people who, prior to online learning, could not attend colleges due to constraints such as time or geographical location. Advancements in technology throughout the 1990's allowed for educational institutes to reduce costs of "distance learning". This allowed them to bring education to larger, broader, audience as the price of education for students also decreased.

In the 2000's, the successful adaption of e-Learning in schools and colleges acted as a catalyst for its incorporation into the business world. Thanks to the introduction and evolution of computers and the internet many businesses and organisations began to use Learning Management Systems to train and educate their employees. Experienced and new employees now had the ability to improve and further expand their skill sets. Even more, people now had the ability to earn degrees online from their homes. E-Learning has

continued to improve and evolve right through to 2017, and will continue to do so. People use technology on a daily in today's world. Through smartphones, iPods, tablets, laptops, PCs and so many more devices available today, technology has become a huge part of our everyday lives. Technology has developed so much that it has gone from initially being rejected in the classroom, to being embraced in the classroom and becoming an integral part of modern education.

Today, a basic e-Learning course, or training, would be easily recognised by many people as a simple slideshow-based, online activity which includes 'next' and 'back' navigation buttons and is accompanied by several incorporated 'true' or 'false', multiple choice question examinations. However, not all e-learning courses follow this blueprint. E-Learning trainings have evolved and transformed from basic slideshow activities and can now be crafted into a wide range of possibilities. An e-Learning course can now be an inherently responsive web-based lesson that provides users with a great learning experience regardless of what type of device the course is being accessed on. Alternatively, it could be an interactive role-playing lesson which requires complex decision-making, or a software simulation which illustrates the click-path throughout an application. The possibilities when creating e-Learning activities are near-infinite. However, due to the fact that there are endless ideas and possibilities for e-Learning courses, there are a set of standards which e-learning software products must meet.

SCORM is the set of technical standards for e-Learning. SCORM tells programmers how to write their code so that it can "play well" with other e-Learning software. It is the de facto industry standard for e-learning interoperability. Specifically, SCORM governs how online learning content and Learning Management Systems (LMSs) communicate with each other

(SCORM, 2017). SCORM is solely a technical standard so it does not set out instructional design or any other didactic concern.

Why is e-Learning valuable

The major advantage of e-Learning is that it can provide many benefits that traditional classroom-based training and learning sessions and lectures cannot. The advantages include:

- E-Learning can be either a synchronous or an asynchronous activity for people to participate in. Traditional E-Learning has always been an asynchronous activity. This means that there was never any predetermined time or deadline in which the learning or training needed to take place or be completed. Each user had the ability to 'go at their own pace' and take as much time as they need to be able to learn and comprehend the material which is being presented to them. However, now more synchronous e-learning is available through services such as web conferencing and chat options. A great advantage provided by e-learning is that it provides you an option to do either style of learning, or both.

- E-learning also has a universal reach. Once placed online, the virtual learning content can be accessed, easily, by people all around the world. This negates the need for generating unwanted expenses such as expensive travel or the tedious task of trying to schedule meetings across multiple time zones.

- Online, e-Learning content and courses can also work on multiple devices. They can span across any range of tablets, smartphones and computers. This allows for

accessibility of content at all times.

- E-Learning is more efficient than traditional learning. E-Learning allows you to develop and distribute electronic courses to hundreds, if not thousands, of people removing the need of organising training sessions and lessons in person.

- Providing lessons and training through e-Learning management systems allows course creators to maintain consistent quality and content. By developing an e-Learning course you can provide all learners the same message consistently. With traditional classroom-based training many factors can affect the outcome of the course such as the wide varying of equipment, the message you are trying to get across, and other conditions from one session to the next.

- The most important advantage of e-Learning for most all businesses and educational institutes is that it results in reduced costs. This applies to both the learners and the teachers of e-Learning content. There is no need to frequently purchase up to date text books for courses and trainings as the content can just be updated on the Learning Management System whenever necessary. With e-Learning in schools and colleges, lecturers possess the ability to host guest lecturers without having to spend excessive amounts of money. It can be accomplished virtually through the use of cameras and microphones for both the guest and the students in order to provide the same level of interaction that could occur if the guest and students were physically present together in the same room. A benefit of this is there would not be a need to have the guest give the same lecture to different groups more than once, as the original session can just be recorded and played back to other groups or people who missed the session.

Areas to Investigate

Through my research so far, I have discovered that the area of e-Learning is an extremely broad one. So far, I have only touched on the brief origins of online learning, along with a small number of benefits it provides. However, both these areas will need to be looked at further for a more in-depth understanding of each. So far, other topics I have seen but have not yet had the chance to analyse and investigate fully include:

- What are the concerns and drawbacks with e-Learning.

- SCORM standards.

- Cognitive Learning Theory by Ruth Colvin Clark.

- Tin Can API which rivals SCORM in the battle to be the most popular e-Learning content standards.

- Market Leaders in e-Learning

- Global e-Learning market

- Adoption and growth of e-Learning in different countries

Feasibility

E-Learning is a massive area. It is constantly growing and transforming and as it does so, e-Learning is becoming a more and more crucial part of our everyday lives. Whether you are currently attending school or college, or whether you are currently an employee in a business anywhere in the world, Learning Management Systems will be used to for trainings and lessons. I feel that the area of e-Learning is huge and that there are so many sub-areas to investigate within e-Learning, several of which I have mentioned in the previous section.

My end goal for this project is to carry out an in-depth comparison and contrast of two e-Learning management systems, either between educational institutes' e-Learning systems such as IT Tallaght's own Moodle and the global Moodle which is used by numerous universities and colleges across North America and other parts of the world, or, two different top e-Learning systems such as Atutor and Eliademy. I want to evaluate two LMSs based on parameters such as the SCORM and Tin Can standards, usability, cost and accessibility, and reach a conclusion on which one is a better LMS to use and what changes could be made to improve both systems. Most e-Learning systems provide people with access to a free demo or a free trial so that they can test out the system meaning there would be minimal costs incurred when carrying out this project.

Research Plan

Date	Topic
02 Oct	Origins of e-Learning Advantages and benefits/Disadvantages and drawbacks of learning
09 Oct	Adoption and growth of e-Learning in different countries
16 Oct	Global e-Learning Market/Market Leaders
23 Oct	What is required to implement a LMS (costs, equipment, etc.) Cognitive Learning Theory – Does it have an impact on e-Learning?
30 Oct	SCORM Tin Can Tin Can vs SCORM comparison and contrast
06 Nov	Project Review with Panel (present/ discuss technologies)
13 – 27 Nov	R+D of suitable technologies – Research to determine 2 suitable LMSs to carry out my tests on etc.
04 Dec	Project Review with Panel (present/ discuss technologies)
11 Dec	Formal Project Proposal
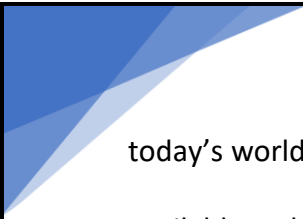
Section 2: Literary Review

E-Learning

<u>Introduction to E-Learning</u>

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In the 2000's, the successful adaption of e-Learning in schools and colleges acted as a catalyst for its incorporation into the business world. Thanks to the introduction and evolution of computers and the internet many businesses and organisations began to use Learning Management Systems to train and educate their employees. Experienced and new employees now had the ability to improve and further expand their skill sets. Even more, people now had the ability to earn degrees online from their homes. E-Learning has continued to improve and evolve right through to 2017, and will continue to do so. People use technology on a daily in

today's world. Through smartphones, iPods, tablets, laptops, PCs and so many more devices available today, technology has become a huge part of our everyday lives. Technology has developed so much that it has gone from initially being rejected in the classroom, to being embraced in the classroom and becoming an integral part of modern education and business worlds.

E-Learning in Education

E-Learning has had a major impact on education in the past decade. It has transformed the way lecturers and teachers can present course material to their students. Several ways E-Learning has transformed education for both students and lecturers for the better include:

- E-Learning has facilitated and encourage a higher degree of interactivity among lecturers and students. Furthermore, it has allowed for easier and more effective coverage of study materials among students.

- Course material can now be made available online instantly. This means that if any student was out sick and missed a lecture, or lives too far away to travel, they can access the topic material for that specific lesson through an online E-Learning portal and not fall behind.

- Course material can be made completely interactive and hosted on a Learning Management System. Lecturers can transform their current course material into an interactive activity containing click-events and quizzes throughout.

- Assessing students has now become easier and more modernised. Lecturers can now create assessments online for their students to complete. These assessments can also

be heavily customised to align with the topics being reviewed and catered towards a lecturer's teaching style. If there is more than one group being assessed, the examination can be modified to provide different sets of questions each group. Certain assessments can even be designed to allow students more than one attempt at passing it. Thanks to E-Learning there is an overwhelming amount of possibilities for lecturers to explore when creating tests for their students.

E-Learning certainly has had a positive impact on the lives on students and teachers for the most part. However, there are some negative impacts that also accompany E-Learning. These drawbacks include:

- Regarding the E-Learning content itself, if it is not designed correctly and effectively, it can have a negative impact on the student. E-Learning content needs to keep the user drawn to the activity they are working through. If standards such as SCORM and Tin Can are not adhered to, the content may not be effective and the student may lose the focus and self-motivation required for E-Learning.

- A big disadvantage of E-Learning stems from the basis that every student is different. Some students may require more face to face time with their lecturer in order to fully understand certain topics. Certain students may have learning disabilities which means they will need more help and assistance than what E-Learning provides. For the most part, E-Learning is a solo learning activity. This is a major disadvantage and is unfair to the students who need classroom-based learning in order to excel in topics and complete courses.

- E-Learning courses can become outdated regarding the material that is being presented due to a lack of input from trainers. It is important that a lecturer ensures

that their online course is updated with the necessary information as it becomes available. Otherwise students will be learning and practicing activities which are no longer being used or relevant.

E-Learning has transformed education. In some ways, this transformation has been for the worse, however there have are far more positives than negatives that have come about from this transformation. E-Learning will continue to reinvent the way in which education is carried out for years to come.

E-Learning in Business

E-Learning has also revolutionised the way that employees in industry are trained to do their jobs. Employee training is considered to be one of the most important elements necessary for organisations to meet business goals such as cost reduction, revenue growth and employee productivity. Today's organisations have been adopting advanced and effective E-Learning trainings to upskill their employees. Some of the benefits that businesses receive by using E-Learning include:

- It can greatly improve an organisations 'Bottom Line'. Businesses that operate in highly competitive markets and situations require flexible and effective training methods to train their employees. While they need to dedicate time to training staff, they also need to dedicate time to production. One cannot hinder the other. E-Learning allows organisations to generate more production hour of employees as it allows for the access of training courses anytime, anywhere. E-Learning will also enable employees to better support their customers as training can be made available

enable employees to better support their customers as training can be made available to thousands of employees instantly when a launch or a product is updated. This will help generate more sales for the business.

- E-Learning can also reduce costs for the organisation. Online training, unlike traditional classroom-based training, can be access anytime and anywhere by employees. Once an e-Learning course has been created it can be repeatedly assigned to different employees as they require it. Furthermore, if you have to pay a specialist to come in to upskill employees in a particular area, these sessions can be recorded and distributed to any future employees of the company negating the need to repeatedly bring in the specialist.

- The greatest benefit an organisation can inherit from E-Learning is an empowered workforce. Knowledgeable and skilful employees are crucial for a business to achieve its goals. E-Learning can help empower employees by providing them the ability to partake in as much training as they need to master any necessary concepts. It is crucial that employees feel that they have all the necessary tools to excel in their employment and be prepared to adapt to any changes in industry. E-Learning also allows employees to complete training courses at their own pace and without the worry of attending certain sessions which have been scheduled at a convenient time according to a different time zone.

Like E-Learning in education, E-Learning in the business world also has some shortcomings to watch out for. These disadvantages include:

- There can be a slow evolution with an online course. Once an E-Learning course has been developed and deployed to employees, it may take a long time to work in any

needed changes to the content. Certain industries such as IT are constantly transforming, and if market conditions are disrupted or an organisations business model changes, the online training available can be quickly rendered useless. This means that time and energy invested to get the course produced and available for use was pointless. However, with standard, classroom-based training carried out with physically present trainers course content can be changed in a lightning fast manner and even 'on the fly'.

- E-Learning courses are generally solo trainings for employees to complete by themselves. However, this can be a disadvantage as it takes away the team building and bonding exercises that employees experience through the face to face classroom style trainings. Training is about far more than just embedding new information into employee's brains. It can be extremely beneficial to create an environment where individual employees deepen and strengthen their relationships with one another by getting to know each other whilst learning in a unique environment all working towards the same goal. This can help create a more inclusive workforce with a great atmosphere. E-Learning will not be able to provide such a benefit.

E-Learning Content Types

The content type of the E-Learning course or training you are creating can be a deciding factor of whether the course will be a success of a failure. It is important to design the course based on the needs of learners and the types of learners that will be using it. The four most common learning content types are:
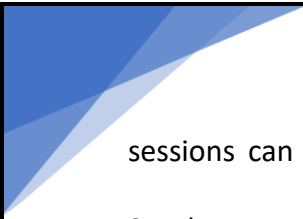
1. **Learner-centred content** - E-Learning content should be catered towards the needs and professional role and responsibility of the learner.

2. **Engaging content** – It is important to ensure the development of an engaging and motivating learning experience by creatively implementing instructional methods and techniques.

3. **Interactive content** – Ensure the learner is not sitting and reading through or listening to a slide show for a long period of time. Some sort of interaction from the user is required to maintain their attention and encourage further learning.

4. **Personalisation** – Course should be customisable to reflect the needs and interests of the learner. Tutors and facilitators should have the ability to monitor a learner's individual performance and progress in instructor-led courses.

The learning content type of a course depends heavily upon the E-Learning methods that have been chosen to implement the course.

E-Learning Methods

Most E-Learning methods are designed to be either Synchronous, or Asynchronous in nature. It comes down to the needs of the learner and the learning objectives the developer of the course chooses which will help decided which of the two categories it will be.

Synchronous E-learning takes place in real-time. Examples include video and audio conferencing in which all parties are required to be present at a given time. It can essentially be a virtual classroom where learners can ask and receive answers to questions instantly through instant messaging or by dialling into the call and speaking with the trainer. These

sessions can be recorded by learners and played back at a later time. Some benefits of Synchronous E-Learning are:

- It helps eliminate the feeling of isolation amongst learners as they are in communication with other learners and the training provider through the learning process. It provides global connectivity and collaboration opportunities for learners.

- Presenter has the ability to personalise the training for each learner should they wish to.

- Synchronous E-Learning allows for the logging and tracking of learning activities along with the possibility continuous monitoring and correction.

However, Synchronous E-Learning might not be suitable for people who have busy schedules as it is not flexible in terms of time. Students will have to abide by a designated time slot in order to attend the live session which may not be possible for most.

Asynchronous E-Learning can be carried out even while the learner is offline. Learners to not have to attend sessions at designated time as Asynchronous E-Learning content is delivered through web, email and message boards which are posted on online forums. Learners can complete these courses at their own pace on a Learning Management System, using the internet as a support tool rather than participating in online virtual classrooms. Some positives of Asynchronous E-Learning are:

- Content can be accessed by learners anywhere and on a 24/7 basis.

- Courses are self-paced which reduces the pressure put on learners with busy schedules.

- There are less social obstacles in place for introverted learners. Some learners suffer

from social anxiety and may feel uncomfortable about the prospect of being forced to participate in online discussions with their fellow peers and learners. Asynchronous learning helps these people as learning in isolation can make them feel safer and more comfortable.

The most effective E-Learning courses will incorporate both Synchronous and Asynchronous learning activities. This will allow teachers and students to receive the benefits of different delivery formats regardless of scheduling or preferred leaning methods. It provides learners with access to instant help if require, while also allowing them to learn at their own pace.

E-Learning Pedagogy

E-Learning can come in many forms. It can be based around the method of self-study, where students work through reading material such as pdf and ppt files and have their queries and doubts resolved in the classroom by the designated subject matter expert. It could also be a game-based learning experience which focuses on creating engagement and motivation for the learner to gain knowledge about certain topics while they play. There are a large number of possibilities and a wide range of forms E-Learning content can take. However, it is a necessity to ensure that the E-Learning which has been created is effective. It is essential that a creator of E-Learning content familiarises themselves with E-Learning Pedagogy in order to create effective E-Learning. Pedagogy is the method and practice of teaching, especially as an academic subject or a theoretical concept. E-Learning Pedagogy is slightly different to standard Pedagogy. Many professionals have their own understanding of the E-Learning Pedagogical key areas, and research is still being funded and conducted to make further

breakthroughs regarding this topic. However, one of the most popular Pedagogical models from E-Learning is Professor Gilly Salmon's 'Five Stage Model'. This theory states that there needs to be a structured developmental process in place for online learning to be a success. The Five Stage Model provides a skeleton for a structured and paced agenda of E-Learning activities. It offers learners with the necessary support and development at each stage to help them build their expertise through online learning. The teacher, or moderator, role is vital in order to the design and implementation of the Five Stage Model. They are responsible for ensuring that learners meet the intended outcomes.

The Five Stage Model is divided into the following stages:

1. **Access and Motivation**

   Stage 1 revolves around the initial setup and welcoming and encouraging learners. There is a responsibility put on the lecturer to ensure that the system has been set up correctly and that every student can quickly and easily access the system, with or without the use of passwords.

2. **Online Socialisation**

   On this level of the Five Stage Model, learners must begin to feel comfortable in the online environment and start engaging and socialising with one another. It's crucial to generate and maintain an environment among learners online where each one of them feel safe and respected, and then show respect to each other. In this step, it is crucial to provide bridges between social, cultural and learning environments.

3. Information Exchange
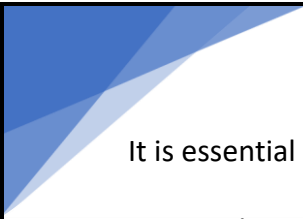
In stage 3, the moderator must ensure that they teach and support the use of learning materials among their students. The learner will interact with the course material during this stage. One problem that can arise for learners at this stage is information overload. It is the responsibility of the tutor to ensure there is an organised structure in place regarding content in order to avoid the confusion of learners.

4. Knowledge Construction

The main focus of this stage is to build an online community that is focused on learning. For the teacher, this is a facilitating process. This is done through conferencing. The teacher will be linking communications received from students back to topics while simultaneously engaging and encouraging other learners to respond. The teacher must summarise the previous topics but also move the group on to new subjects when necessary. By stage 4, the teacher should also be delegating leadership roles and responsibilities to learners.

5. Development

The final stage of the Five Stage Model is development. During this phase, learners should be taking and accepting responsibility for their own learning, and gaining more confidence and beginning their transformation into becoming critical thinkers. The tutor should provide learners with links to topics outside the closed conferences and continue supporting and responding to learners. Learners should now be discussing ideas and concepts at a much deeper level than before.
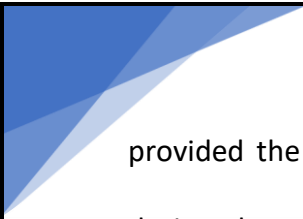
It is essential that the E-Learning content you create is effective and beneficial to students. If content is not interesting are designed in a certain way in which it can grip a user and hold their attention span for the duration of the course, it will not be well received and will have a negative impact on the learner. Although it is important to have effective content, there are also E-Learning standards that must be adhered to with the creation of online learning content.

E-Learning Standards

Similar to how people need a common language to be able to communicate with each other, E-Learning content and Learning Management Systems (LMS) also need a common language to relay information back and forth from students who are taking E-Learning courses. Standards have been invented so that any content created by any vendor will be able to speak with any LMS created by any vendor. The two most popular E-Learning standards today are SCORM and Tin Can API.

Shareable Content Object Reference Model, or SCORM, is a set of technical standards for E-Learning software products. There have been three different versions of SCORM. SCORM 1.1 and SCORM 1.2 were both released in 2001. SCORM 1.2 would go on to become one of the most widely used E-Learning standards today as it resolved all of the issues which plagued SCORM 1.1 and had been updated to use a JavaScript framework. This required LMSs to wrap E-Learning courses in a frame and use a JavaScript API to allow communication between the course and the LMS. SCORM has since evolved to become SCORM 2004 which is the most complex version that has been developed as it supported the sequencing of content and

provided the ability for the LMS to manage navigation of the E-Learning content. It was designed to work in a desktop environment which required a learner to be logged in online to an LMS for the recording of information. This is not completely ideal for E-Learning today as many different types of devices exist and learners can use any one of them to complete courses. There are also restrictions in place with SCORM regarding the information it can record from a course. By design, it can only record scores, completion, pass or fail and answers to questions so in 2010 research began into a new E-Learning standard which later would become known as Tin Can API.

The weaknesses associated with SCORM 1.2 triggered the development of Tin Can API. Tin Can, although separate to SCORM, is often referred to as the next evolution of SCORM. Tin Can has redefined some of the fundamental practices of tracing E-Learning content. It stems from the belief that learning happens everywhere. Rustici Software, who developed this standard, chose the name 'Tin Can' to describe the two-way conversations this technology would track, making it easier for LMSs to communicate with one another. The big difference between SCORM and Tin Can API is in the learning that each standard can track. SCORM is limited in what it can track whereas Tin Can API has the ability to track almost any activity. Tin Can provides a much more in-depth, detailed view of a learner's progress through both offline and online learning environments. The methods of learning it can track are limitless. Tin Can simplifies the manner which learning is recorded as it offers multiple ways to track learning statements. With Tin Can, each statement is made up of three elements, a noun which is an actor, a verb which describes the action taking place and an object which is the 'what' part of an action. These three elements together form a structure know as Tin Can's Syntax. Tin Can records these statements and uses them to track data regarding learner
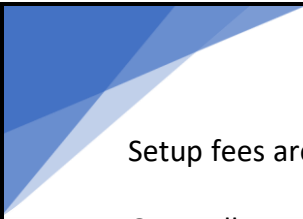
actions and sends a report back to an LMS, or any other application that recognises Tin Can language. Tin Can's flexibility makes it very well suited for today's E-Learning environment in which users access all sorts of materials in any location. Tin Can allows for the tracking of all learning experiences in one simple, consistent format.

Financial Aspects of E-Learning

The costs associated with an E-Learning implementation can be divided into hard and hidden costs. Hard costs refer costs incurred from the purchasing of a Learning Management System, licensing fees which must be paid, pricing models or once off setup fees. These costs can range from thousands of euros, to no cost at all. Pricing models of LMSs are the most visible costs incurred.

Pricing models can be split into two different categories to choose from: self-hosted, or cloud-based. Cloud based LMSs can use different pricing scheme such as Pay-Per-User which will charge organisations for each user which is registered to use the LMS, Pay-Per-Use which will result in a charge every time the LMS is used, or simply just charge a License Fee which could be a one-time cost to allow access to the LMS for a set period of time. Self-hosted LMS costs are somewhat different. Self-hosted LMSs can be hosted on the servers of the company which have purchased them, or 3rd party servers. Pricing models associated with a self-hosted LMS cover different licenses such as Periodic Licenses in which a hosting charge will be incurred on a monthly or yearly rate, Free Models which is open-source software such as Moodle which is accessible by anyone and with no up-front fee, and Perpetual Licenses which require a one-off cost that guarantees use of the LMS for as long as the client requires.

Setup fees are a once off payment to LMS providers for the initial installation of the system. Generally, a cloud-based setup fee would require a cost of roughly €4000 - €7000 whereas a self-hosted LMS setup can be more expensive and reach a cost of up to €25000. Setup fees usually cover the cost of installation of the LMS, training of the staff so they can use the LMS efficiently, along with a basic level of support such as email and a basic customisation such as colour schemes.

Hidden Costs of an LMS implementation are costs that you cannot see from the offset and can arise after the purchase of an LMS. The most common hidden costs associated with an E-Learning LMS implantation include:

Upgrade Fees: In the event that your organisation or student intake numbers should grow, it is important to ensure that the LMS has good scalability to handle the increased number of users. Some LMS vendors will demand an upgrade fee in these circumstances.

Customisation Fees: If you want to heavily customise your learning portal to better represent your college or organisation or have a custom layout for all pages within the portal, you will have to pay an extra fee to do so.

Maintenance Fees: It will require further costs to carry out operations such as data migrations, system testing, updates, bug fixing and keeping the up-time of your system as high as possible. You may have to pay your LMS vendor or, within an organisation you may have to pay for your IT staff to be trained to enable them to do these tasks.

Support: There are certain issues that may arise within your LMS that cannot be

resolved through video tutorials or by emailing support. Some issues may be too complex to fix by yourself and might require you to pay a cost to receive professional help to resolve the issue.

There is usually an inverse relationship between hard costs and hidden costs. Quite often, LMSs with a higher hard cost have lower hidden costs. This is due to the fact that the more expensive LMSs sometimes help justify their cost by including perks such as professional customisation, professional training for your IT staff and ongoing customer support, all of which can be hidden costs with a lower priced LMS.

Current E-Learning Applications

Two of the current, most popular Learning Management System software applications are Edmodo and Moodle.

Edmodo is an online web-based system that provides content sharing functionality, communication tools, feedback receival in real-time, and classroom management. It is a secure system which provides social learning for teachers, students schools and even entire districts in some circumstances. Edmodo can be integrated with both Google Docs and Office 365 and can be implemented on Windows, Web-based, Android and iPhone/Mac devices.

Edmodo provides many features including:

- Online classroom discussions.

- A network that can connect students, parents and admins online.

- Ability to measure each student's progress throughout the course.

- Poll creation for students to take part in.
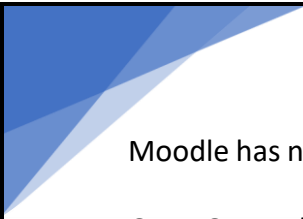
- Ability to award badges to students.

- Personalise your system with apps of your choice.

Edmodo is hosted on the cloud and is supported in many languages such as Japanese, British and American English, German, Indonesian and more. It is focused medium businesses and large enterprises and provides both phone support and training support to their clients. Edmodo is also free to use for students and teachers while offering no enterprise pricing plans.

Moodle is an easy to use free Learning Management System that allows educators to create and host a private website populated with dynamic courses which allows for learning to take place anytime, anywhere. Moodle can be integrated with far more program than Edmodo, and can be integrated to meet different needs of different websites. Moodle is currently only supported on Windows and Android devices as opposed to Edmodo. Moodle is superior to Edmodo in terms of the features it provides. The features of Moodle include but are not limited to:

- Provides collaborative tools and activities to use.

- Personalised dashboard.

- Regular security updates.

- Customisable site layout and design.

- Plugin and add-ons management.

- Simple and easy to use text editor

Moodle can be used on any device as it is web based. This also allows it to be accessed anywhere in the world. Over 95 different languages can be configured on Moodle.

Moodle has no price plans. It is a free platform with no licensing fees and is offered under the GNU General Public License. The GNU license allows for the adaptation, extension and modification of Moodle for both non-commercial and commercial projects. Moodle is catered towards small and medium businesses, large enterprises and freelancers which is a wider target audience than Edmodo. Moodle also provides more support to its clients than Edmodo as it provides phone, ticket and live support.

Technologies for Creating E-Learning
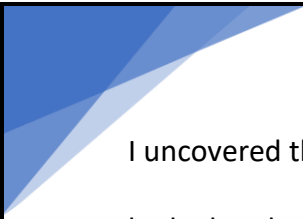
While carrying out my literary review, I briefly stumbled across technologies which can be used to create and implement E-Learning. One free program that I noticed was iSpring Suite. iSpring suite provides a PowerPoint plug-in which allows users to create a slide show of learning materials and then convert it into E-Learning content that is compliant with SCORM or Tin Can. This could be very helpful as it would allow for the creation of similar content which conforms to both SCORM and Tin Can, which could then be tested extensively in order to compare and contrast the two to see how both standards hold up against one another. iSuite can be downloaded and installed in minutes and can be used instantly to create content.

Conclusion

Over the course of this literary review of E-Learning I have drastically increased my knowledge of the subject area. I found that E-Learning plays a major role in both schools and organisations alike. It has transformed how educators can teach their students, and also how businesses train their employees. E-Learning has enabled students who may be far away from their institute and unable to travel most days to still receive the same education as students who are able to attend daily. This has been accomplished through Learning Management Systems which are used to host E-Learning courses and content which can be accessed anytime, anywhere. Organisations can now provide training to employees located all over the world through either virtual class rooms or learning hubs which helps employees retain fresh and relevant skills.

I discovered and learned about the four most popular learning content types which are engaging content, interactive content, personalisation and learner-centred content and how they are heavily influenced by whether the method chosen for the content is synchronous, which requires all students to be present at a dedicated time, or asynchronous, which allows students to complete learnings and courses when they have free time to do so.

I then went on to learn about one of the most popular E-Learning Pedagogical models which is the 'Five Stage Model' by Gilly Salmon. This model outlines a strategy and structure which contains 5 stages: Access and Motivation, Online Socialisation, Information Exchange, Knowledge Construction and Development. Together, if implemented successfully, these 5 steps will help create a successful online social learning environment which engages and benefits learners and course moderators.

I uncovered the two main E-Learning standards which are SCORM and Tin Can API and looked at the differences between them. SCORM is an older standard and is limited in what it can record compared to Tin Can. The flexibility of Tin Can makes it more suited for modern E-Learning as, in today's world, all sorts of content can be accessed by any number of devices at any given time by learners.

The financial aspect of E-Learning was another area I wanted to consider. I found that the cost of an E-Learning LMS implementation can range from nothing to thousands of euros. There are also different pricing models with an LMS. The pricing models are self-hosted and cloud-based. Each pricing model has different pricing schemes regarding their licenses. Cloud-based LMS price models have different pricing schemes such as Pay-Per-Use, -Pay-Per-User or a one-off License Fee cost. Self-hosted LMSs may also require the purchase of a license. There are different licenses which can be acquired. For example, one can be free models, meaning it is open source and there is no fee required to be paid up front, while another one is a Perpetual License, which requires a once-off payment that allows the client to use the LMS for as long as they wish. I also found out about the hard and hidden costs associated with LMSs and how it is important to consider all aspects when purchasing one. For example, choosing a cheaper LMS solely based on price may actually cost a client more in the long run than it would have cost them had they chosen the more expensive LMS from the get go.

I examined two of the most popular E-Learning applications available today which are Moodle and Edmodo. I looked at the features each provide such as regular security updates or a badge award system for students. Moodle provides more features than Edmodo. Edmodo is also lacklustre with the support it provides as it only provides phone and training

support, as opposed to Moodle who provide phone support, support using a ticketing system and live support.

Finally, in preparation for the technology research, I looked at an app I came across during my research called iSpring Suite. iSpring Suite allows for the creation of both SCORM and Tin Can compliant content in PowerPoint using a plug in. This could be useful during the next phase of my project.

Now that my research phase has concluded, I plan on moving on to looking into the technologies that are available for use in the area of E-Learning.

Section 3: Technology Review

Introduction

Background

During my literary review research phase, I discovered that E-Learning is an integral part of the modern education and business worlds. E-Learning has positively transformed and revolutionised the way students learn and employees are trained. I then uncovered that the two most popular and widely used E-Learning standards are SCORM and Experience API (xAPI). I also evaluated the cost of different E-Learning implementations such as cloud-based and self-hosted implementations. Another discovery made was that the two of the most popular E-Learning applications available today are Moodle and Edmodo.

Now, leading on from the literary review phase, the evaluation and testing of different technologies needs to be carried out in order to discover which are suitable for the technical iterations which will be required next semester.

Motivation

My objective is to carry out an evaluation of different technologies, documenting what I am testing, how I am testing, it and recording any results along the way. I hope to be able to determine suitable technologies to use for my physical implementation in Iterations 1, 2 and 3 during the next phase of my 4th Year E-Learning project. I also hope to help discover technologies which will be of no use and deem them as unsuitable during this technical review phase as it will be extremely beneficial to discover what will and will not work now, rather than next semester when it is time to get hands on with the project. Overall, I am hoping

to uncover technologies that will allow me to create and test E-Learning content.

<u>Contribution</u>

Throughout the technical review stage, I hope to review as many technologies as possible. I have divided the technologies which I need to investigate into three different sections. These sections are:

- E-Learning authoring tools

- Learning Management Systems

- Learning Record Stores

I will be evaluating different technologies from each section and determining which is the best E-Learning authoring tool, Learning Management System (LMS), and Learning Record Store (LRS) to use for my E-Learning Project.

Experimental Setup

In order to successfully carry out testing, I needed to first use E-Learning authoring tools to allow me to create an E-Learning course to test on different Learning Management Systems.

I tested two different authoring tools whilst creating the content for the experiments. For my experiment, I began by designing a basic E-Learning course. The topic I chose to base the course around was the Easter Rising of 1916. I researched the topic and discovered a site containing 15 interesting facts about the Easter Rising. I decided that I would base a course around these 15 facts. I opened PowerPoint and began to design my course. I used one slide per fact. Once I had finished creating the slides, I used the authoring tool features to add in a short, 4 question exams at the end.

Once I had finished creating my quiz questions, I published the course twice. The first time I published the course, I did so in adherence to the SCORM 1.2 standard. The second file I published was in adherence to the xAPI standard.

My objective for this experimental phase is to test different Learning Management Systems and evaluate if, and how well, they can run both, the SCORM course I have built, and the xAPI course I have built.

iSpring Suite 8.7

The first E-Learning authoring tool I tested was iSpring Suite 8.7. iSpring Suite is a PowerPoint extension that allows content creators to transform their slide decks into an interactive E-Learning course. iSpring Suite supports all features of PowerPoint including slide transition effects, word animations and slide triggers.

iSpring Suite has a special feature called Presentation Explorer. Presentation Explorer allows content creators to adjust the structure of the entire presentation, create a hierarchy of slides, implement and control course navigation and set the duration that the course will run for.

iSpring Suite negates the need to create the same course multiple times for different devices as it contains an adaptive player which automatically adjusts all navigational elements to fit the size and orientation of the screen on the device you are using whether it be a computer, tablet or mobile phone. There is also a preview feature which allows you to see for yourself how the courses you have created will appear on each device.
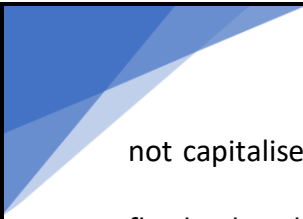
Another great feature of iSpring Suite is that it provides templates and assets to help creators to design courses in a timely manner. These include pre-built course templates, over 30,000 photographic characters to help make the course interact with learners on a more personal level, course backgrounds to customise the course to have its own setting and navigation controls including buttons and icons. Any of these features can be integrated into courses to try design the most efficient and interactive E-Learning course possible.

If the PowerPoint slide text is not enough to clarify or expand on certain topics within the course, iSpring allows for the addition of audio and video narrations to slides. There is a built-in audio and video editor with iSpring Suite which allows creators to perform actions such as removing fragments from your audio and video segments, remove background noise, and fade an adjust volume.

iSpring Suite's greatest feature the iSpring QuizMaker. The QuizMaker allows creators to create examinations and integrate them into the course. There are 23 question types in total and they are split into two sections: graded questions and survey questions. You can also provide custom feedback to answers and set a pass percentage on the exam.

While using iSpring Suite, as previously mentioned I created a course about the 1916 Easter Rising with an integrated test. As I was creating this course purely for experimental purposes, I wanted to see how each question type worked. All the questions which I created for the quiz were based on the course content itself to ensure anyone taking the course. The first question was a multiple response question in which I asked leaners who, out of the people I had listed, had signed the Proclamation of the Irish Republic. For any incorrect answers, I provided feedback as to what the correct choices were. The second question I created was a multiple-choice radio question where I asked the user which county the first official shot of the rising was fired. I also provided feedback to incorrect answers indicating what the correct choice was. For the third question, I chose the type in question format where the user was required to write the name of the person they believed took command when James Connolly was injured during the start of the Rising. For this type in question, I wanted to test whether it was case sensitive or not. Originally, I had four answers to this question, two were the name of the person in English and Irish with the first and last name capitalised and the other two were

not capitalised. I previewed the test 4 times to try each answer. As suspected the test ran flawlessly. I then edited the quiz and removed both lower case answers. This left me with just the English and Irish name with capital letters as the two answers. I ran the test again and this time typed in the name with all lower-case letters. In both instances, the question was marked as correct which allowed me to discover that the iSpring Suite type question is not case sensitive. Once again, I chose to provide custom feedback for this question indicating what the correct answer is. The final question of the quiz was a numeric question in which the total number of people who signed the Proclamation of the Irish Republic was required. For incorrect answers to this question, I provided feedback with the correct number but also listing who the individuals were.

Once I had designed the course content and the quiz, I began to work on the grading system for the entire course. I decided to set a pass completion of 75% on exam meaning 3 questions needed to be answered correctly. However, I also set the slides viewed to be a graded item as to ensure learners read through every slide. I set each slide viewed to carry a weight of 1. This means that the passing score for this course 87.5%.

Once I had finished customising the grading aspect of the course, I published the course. I chose to publish the course for an LMS and in a zip output for SCORM 1.2, and then again for xAPI.

The one issue I found with iSpring Suite was that it is only a trial. A subscription must be purchased to use it for more than 14 days. However, I discovered a workaround with this issue. I could test an iSpring Suite trial inside a Windows 10 virtual machine. I am easily able to delete the virtual machine once the trial expires and set a new one up to get another trial. The good thing about this is that the courses I created will not be lost as they are saved as

regular pptx file and iSpring Suite is only used to publish them and turn them into E-Learning courses.

Adobe Captivate 2017

Adobe Captivate is quite similar to iSpring Suite in the features it provides for creating E-Learning content. Adobe Captivate provides the ability to create both SCORM and xAPI compliant E-Learning content for user on any device. Adobe Captivate also has an intuitive user interface and provides key features such as the ability to incorporate comprehensive quizzes to your courses, the ability to add video and voiceovers to learning content, and a collection of themes to choose from for creating a course.

I managed to create similar courses with both iSpring Suite and Adobe Captivate. Both followed the same structure of 15 facts about the Easter Rising, accompanied by a 4-question quiz. I discovered that with Adobe Captivate, you cannot have just one slide for the quiz. Each question had to be its own slide, whereas with iSpring Suite, the entire quiz was formatted into a single slide.

One major issue I found with Captivate was that in many of the windows within it, information was cropped out. For instance, when I tried to choose the different quiz question types, the popup window was not wide enough which lead to explanations about each question type being cut off, and there was no option to scroll to view the cut off information. The same issue occurred again when I tried to publish my course. Some publishing options were cropped out of the window and were unable to be selected. This essentially left me stuck in a state of limbo as even the option to cancel publishing could not be seen, making it impossible to click

on anything else within Captivate. I researched this issue online and discovered that many others were having the same issue with Adobe Captivate. It appears that this is an issue that requires a patch to be released by Adobe. This issue made Adobe Captivate, almost impossible to use. I could deign the courses and add the quiz slides, but then I could not publish the courses.

Adobe Captivate comes as a free 30-day trial version, however, similar to iSpring Suite, this is not a major issue as I could implement it in a virtual machine, discard the VM when the trial runs out, set up a fresh virtual machine, and then repeat the process as needed.

Due to the issue which cut out key functions within the publishing window for the E-Learning content with Adobe Captivate, I was forced to use the iSpring Suite courses throughout the experimental phase.

Learning Management Systems

Once I had created my E-Learning courses, I needed to test different Learning Management Systems to host them on.
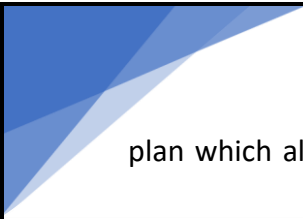
MoodleCloud

One LMS which I tested was MoodleCloud. MoodleCloud is a cloud-based learning environment which is provided by Moodle. Moodle Cloud provides a free plan which allows you to get started immediately. The free plan can handle up to 50 users and has a max file storage of 200 MB. It contains the latest version of Moodle and allows for creators to have unlimited courses and activities.

I signed up for a MoodleCloud account and created the domain 'kylejuthan.moodlecloud.com'. I was the sole administrator and now had full control over my own LMS through MoodleCloud.

I began testing this LMS with my SCORM version of the E-Learning course I created. I uploaded the zipped E-Learning course to MoodleCloud and ran the course in its entirety to ensure everything ran correctly. Everything ran fine and once I had completed the course, I was able to see the percentage and grade I received from it.

I then tried to upload my xAPI version of the course to MoodleCloud. However, MoodleCloud would not accept the file. MoodleCloud only supports SCORM, as does regular Moodle. However, with the regular Moodle implementation, you have the option to subscribe to a

plan which allows plugins on Moodle. The drawback with MoodleCloud is that it does not support any plugins no matter which plan you are on. MoodleCloud is only going to be able to test SCORM E-Learning content. At this stage I realised that I may have to use two different Learning Management Systems, one for SCORM and one for xAPI, if it was not going to be possible to find a suitable LMS which supports both.

I wasn't satisfied with just testing MoodleCloud for one user, i.e. myself. Therefore, I chose to set up an account for a new user. I created this account and assigned it to my second email address and logged onto a second computer. I enrolled this account in the E-Learning course I created, and then completed it. On the main administrator account, I could see the progress of this new user and how they performed in the course. I was also able to produce a progress report of how they did in the course in the form of a Microsoft Excel file which I could download and review offline.

Overall, I found MoodleCloud very easy to use. It has a nice user interface and there is plenty of support under the 'Administrate site' tab to help you with any objectives you want to achieve.

ProProfs Training Maker

Another LMS I tested was ProProfs Training Maker. ProProfs, like MoodleCloud, allows for the hosting of E-Learning content. ProProfs provides tools to create courses as well as hosting pre-built courses.

I signed up for the free trial of ProProfs in order to begin testing it. Once my account was created, I received access to the platform and created two courses. I named the first course

'Easter Rising xAPI' and imported my zipped xAPI E-Learning course into it. Then I called the second course 'Easter Rising SCORM' and imported my zipped SCORM E-Learning course. I then took both courses, along with their tests, to investigate whether ProProfs would provide any issues. ProProfs, unlike MoodleCloud, could support both the SCORM course and the xAPI course. Both courses ran without any issues.

I noticed that, once I had gone through the courses, ProProfs did not recognise my attempt. It did not record any of my results or grades from the courses either. Unlike other Learning Management Systems that I tested, ProProfs does not recognise the administrator as a learner. With other LMSs, I could test the courses and have my progress recorded while being logged in to my administrator account. Therefore, it was a necessity on ProProfs to create user accounts. It was not clear how to create users on the platform. Eventually I found the feature and created a user, using my alternate email. I created the account and selected enrolled them in the two courses I created, however, no email was sent to the email address specified. Assuming that I made an error during creation, I decided to delete the user and create them again. Once again, no email was sent. After some investigation, I discovered that once I created the user and assigned them courses, I had to configure their account again and find the option to send an email. I found this quite tedious as other LMSs often send the email once the account has been created for a user.

Once the email was received, I decided to test the LMS and courses on my mobile phone. I signed in to the account which was generated and took part in the courses assigned to it. Once I had completed the courses, I was able to see the user reports for both courses indicating how the user performed in each course. This user report was one of the least detailed reports from all LMSs I tested. I purposely answered questions wrong in one of the

course's quizzes to test if it would recognise it in the report. However, both courses just had a completion percentage, but no grades.
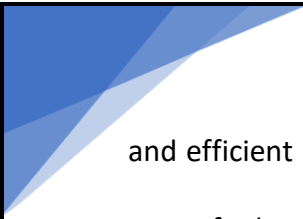
The main draw back with ProProfs is that it is a 14-day trial. iSpring Suite authoring tool is also a trial. However, the reason why iSpring Suite being a trial is not an issue is because it is only used for creating a course. It does not store information, it simply transforms your slide deck into an E-Learning course, whereas the Learning Management System records course progression and user information. The issue with ProProfs being a trial is that, once the trial ends, you will still be able to use the platform, however, all user data will be wiped and it will not be able to record any more.

I found ProProfs to be quite useful in terms of how it can support SCORM and xAPI standards. However, I also found the entire LMS unnecessarily difficult to use. I struggled, in the beginning, to find the option to create a course and was left to just 'click around' until I found it. There were no helpful links and documents, like with MoodleCloud, which gave direction on how to use the different features and navigate the platform. I felt that ProProfs essentially leaves creators to 'figure out themselves' how the platform operates.

Docebo

During my time searching for different Learning Management Systems to test, I was having trouble finding multiple Learning Management Systems to test, which claimed to support xAPI content. After searching for some time, I stumbled across an LMS called Docebo.

Docebo is a cloud-based LMS which supports SCORM and xAPI E-Learning standards. Docebo allows creators and administrators to manage, track and deliver learnings to user in an easy

and efficient manner. Docebo also has a unique Q&A feature built in. This feature acts as a type of educational social network. User can post questions and receive answers from their peers. Answers can then be liked and disliked, illustrating what the best response or answer to a question is.

I signed up for a trial of the Docebo LMS and uploaded my courses. The SCORM course was accepted by Docebo and worked fine. However, strangely, the LMS would not allow me to import the xAPI course. I kept receiving an unknown error. This was the same course which I used on every other LMS that claimed to support xAPI. I made the decision to republish the xAPI course, with the assumption that perhaps it had been corrupted somehow. However, even the freshly published xAPI course would not be accepted by Docebo. I searched for a solution to the issue, but to no avail. Therefore, I was only able to test if the SCORM course ran efficiently.

After importing the SCORM course, I created a new user and assigned them to it. I then logged in with this user and participated in and completed the Easter Rising SCORM course. Once I had completed the course with the new account, I could view their progress on my main, administrator account. Docebo has a fantastic reporting feature. It contains reports on the course itself, indicating how many learners are enrolled, what percentage of learners have started, not started and completed the course, what are the most and least popular courses, and what courses have been completed the most times and the least times. It also contains a report on each individual user. The user report contains information such the users highest, lowest and average test scores, recent test results, courses they are currently enrolled in, their most viewed course, their activity on the LMS for the last 12 months and the total time they have spent partaking in courses. Both the user and course report can be downloaded

and printed in a PDF format for review.

Docebo is a very easy to use LMS. Navigation throughout the platform is clear and concise, and there is plenty of support and guides to follow under the administrator tab, like MoodleCloud. The one main drawback with Docebo was the fact that it would not accept my xAPI course and there was no solution or workaround available that I could find.

SCORM Cloud

Another Learning Management System, which was one of the last platforms I investigated, was SCORM Cloud. I overlooked SCORM Cloud for some time purely due to its name. There is a plethora of Learning Management Systems which support SCORM, but not as many that support xAPI. I assumed that, due to the fact this LMS was called SCORM Cloud, it was only going to support SCORM courses. However, I was pleasantly surprised to discover that it also claims to support the xAPI standard too. Similar to MoodleCloud, SCORM is offered through many plans with one such plan being a free plan named 'The Trial'. The free plan includes the course sandbox which allows for the unlimited testing of E-Learning content, a 100 MB storage limit and the ability to handle 10 registered users. Although this plan named 'The Trial', from what I have researched about SCORM Cloud, there is no expiry date on this free subscription. I signed up for the free subscription of SCORM Cloud and was ready to begin testing the LMS.

In adherence with my standardised testing methods, once again I began by trying to host both my SCORM and xAPI courses on SCORM Cloud. First, I tested my xAPI course. SCORM cloud accepted the course and ran it flawlessly. It was the exact same for the SCORM version of

the E-Learning course I imported.

Next, I created a new user and assigned enrolled them in the two courses which I had imported. I signed in to this account on a different device and partook in both courses. On my administrator account I could view the users progress and grades. SCORM Cloud also has very good reporting functionality. In the user report, I was able to see how many courses the user has started, completed and passed, the total minutes they have spent training, their average exam score, and when they are learning.

The only issue I can find with SCORM Cloud is its low storage limit of 100 MB. However, it is not a major issue as with the two courses I imported to the SCORM cloud, only 13 MB was used of the storage. Furthermore, if the limit were to be exceeded, and I were to test how each standard can handle different pedagogies, I can test a pedagogy and then remove it from the cloud storage to make space for another pedagogical test.

SCORM Cloud was very easy to use. It has a nice graphical user interface and navigation of the LMS was easy and efficient. There is also a help button on every page which allows creators and users alike, to search for resolutions to any issues they are having or any task they wish to carry out.
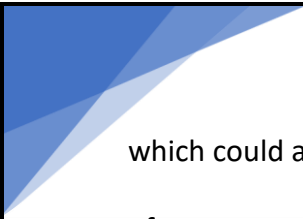
Learning Record Store

An LRS is a system which is responsible for storing and returning data about xAPI learning experiences, job performance and achievements. An LRS is required in order to do anything with the xAPI standard. An LRS enables tracking of a broad range of learning experiences. These learning experiences can be anything from real world activities, to mobile apps, and even to job performance. The data from these experiences can be shared with other systems to allow for reporting analytics and to also support adaptive learning experiences. If I was going to be testing the xAPI standard, I would also need to find a suitable LRS. I tried to implement two different Learning Record Stores during this experimental phase.

SCORM Cloud

Before I looked at SCORM Cloud from an LMS perspective, I had looked into trying to get an LRS called Learning Locker implemented. However, I encountered difficulties trying to get Learning Locker up and running. I then decided to move on and continuing investigating LMSs. Once I began testing SCORM Cloud, I discovered that it has a built in LRS for all xAPI courses. While I was testing my xAPI E-Learning course, I was able to see a live record of what I was doing in the course. The SCORM Cloud LRS records the date and time I accessed each slide, the date and time I accessed the quiz, the exact response I gave to each question, and what percentage I received in the quiz. There is also the option to filter the reports which the LRS are recording and producing. You can use this feature to search specifically for a user's email, if you only want to see result from a specific user. You can also filter by the activity ID

which could allow you to see all data recorded for a certain course. There is also a good level of support provided for the SCORM Cloud LRS. As it is part of the SCORM Cloud itself, it also contains a help function at the bottom which allows users to search for solutions and guides. The inclusion of a Learning Record Store within the SCORM Cloud LMS proved to be a great bonus and another excellent feature of the platform. There is even the possibility of using SCORM Cloud as a standalone LRS, and using a completely different LMS to host the content if need be.

Learning Locker

Learning Locker is an independent LRS which enables E-Learning creators to deliver professional, enterprise-level data management for big learning data. This open source big data platform provides some of the best aggregation, automation and analytics available for E-Learning, while also giving complete flexibility in deployment. It allows you to store, aggregate and share data with ease.

I tried to install a new instance of Learning Locker. While I was going through the installation, I discovered that a server was required to complete the installation. Once I saw this, I immediately began to look for workarounds. I found one article which specified that it would be possible to install and run Learning Locker on an Ubuntu virtual machine. I downloaded an Ubuntu VM and tried to get Learning Locker installed. Unfortunately, I could not manage to get Learning Locker installed.

Analysis

I was going to be testing many different technologies across three areas: E-Learning authoring tools, Learning Management Systems and Learning Record Stores. Therefore, I decided to implement a basic grading system for all of the technology types in order to help me evaluate what would be the best technologies to choose going forward. The grading system I decided to use was solely based on my experience with the technologies, meaning any issues I encountered would be factored in.

E-Learning Authoring Tools Analysis

I used two different authoring tools to try and create my E-Learning content. I decided to grade each tool based on whether or not they allowed for the creation of SCORM and xAPI content, the features that they have and how easy the tool was to use. I decided to rate each factor from 0 to 5. With regards to where the tool can create SCORM or xAPI content, I decided to rate it 0 if it cannot create it, and 5 if it can in order to generate a consistent ratings table. The final grades I had once I was finished testing each E-Learning authoring tool were as follows:

Tool	SCORM	xAPI	Features	Ease of use	Total Score
iSpring Suite 8	5	5	5	4	19
Adobe Captivate	5	5	5	1	16

Learning Management Systems Analysis

As I was progressing through testing each LMS, I decided to give them a rating out of 5 under a several headings. The aspects I choose to mark them on were whether or not they supported SCORM and xAPI, how easy was it to use the LMS and upload my courses and the level of support available within the LMS. It made no sense to me to have a check mark for the support of SCORM or xAPI, and then use figures to review the other headings. Once again, for convenience purposes, I decided to mark the xAPI and SCORM columns as 0, if the LMS does not support it, and 5, if it does. By the time I had tested all of the Learning Management Systems, the rankings were as follows:

LMS	SCORM	xAPI	Ease of Use	Support	Total Score
MoodleCloud	5	0	4	5	14
ProProfs	5	5	2	1	13
Docebo	5	0	5	5	15
SCORM Cloud	5	5	4	3	17

Learning Record Store Analysis

I had the intention of investigating and testing two different Learning Record Stores during this experimental phase. However, due to complications I was only able to test one LRS which was SCORM Cloud. Although I was only able to test one, I still felt it necessary, from a personal standpoint, to rate the SCORM Cloud LRS. The key factors which I wanted to assess the LRS on were how easy it was to use, the level of depth of the data it can record, the ability filter and search for specific data, and the level of support which is available. Once again, the ratings scale was 0 to 5. Once I had finished spending some time testing how the SCORM Cloud Learning Rescored Store operated, I reached the following conclusion regarding grades:

LRS	Ease of use	Depth of data recoded	Data Filtering	Support	Total Score
SCORM Cloud	5	4	4	3	16

Proof of Concept Report

My goal for the project is to test different pedagogies with both the SCORM and xAPI E-Learning standards. SCORM and xAPI are the two most widely used E-Learning standards when creating online content and courses. Even though xAPI is a newer standard, and claims to be a more beneficial standard than SCORM, content creators often prefer to choose the SCORM standard over xAPI. My overall objective of the project is to hopefully investigate both standards, pitting them against each other through different pedagogies, and test them to determine which standard fairs best in which environment.

After reviewing all of these different technologies, immediately I believe that I can rule out Adobe Captivate 2017 as an option. This is due to the bug that resides within Captivate, which renders it almost impossible to use. I was not able to see explanations of question types and, even worse, I was not able to publish courses because the option was cut off. Therefore, I believe that iSpring Suite 8.7 is the most suitable option to use for my project. It allows me to create effective E-Learning courses in adherence to both the SCORM standard, and the xAPI standard. It also allows for the incorporation of quizzes to the courses and offers a wide variety of question types to choose from.

From my testing of the Learning Management Systems, I can safely conclude that two options which I believe are not suitable for what I want to achieve with my project are ProProfs Training Maker LMS, and Docebo LMS. The ProProfs LMS was difficult to navigate and use. There was also little to no support available, and no guides to help understand how to use and take advantage of different features. With Docebo, it was a very good LMS with plenty

of support available. It had a great user reporting feature and was relatively easy to use. However, the issue with it was that it would not accept any xAPI courses which I tried to import to the LMS. This meant that it would only allow me to test SCORM E-Learning courses.

With Docebo and ProProfs out of contention, it left me with a choice between two very good Learning Management Systems in MoodleCloud and SCORM Cloud. Both LMSs have great perks and features. MoodleCloud has a very good reporting feature in which you can download data regarding course details or user details. MoodleCloud was also very easy to use. The one issue with Moodle Cloud is it does not support xAPI and does not allow plugins, which could make it possible to host xAPI content on the platform. SCORM Cloud supports both standards, and has a reporting feature like Docebo, which had the best reporting tool out of all LMSs I tested. In my opinion, the SCORM Cloud LMS is the most suitable option for my project.

Another factor which makes SCORM Cloud the most suitable option for my project is the fact that it has a built in Learning Record Store. This LRS records a high level of data about xAPI courses and users, and allows for the filtering of data to find specific entries and results. The SCORM Cloud LRS was easy to use and to navigate around. Therefore, SCORM is the best LMS/LRS to use and most suitable for my project.

Conclusion

From my testing and analysis of different technologies, I believe that the best, and most suitable options to use for my project going forward are iSpring Suite 8, for its fantastic E-Learning authoring features and abilities, and SCORM Cloud, for its great Learning Management System and Learning Record Store features. I believe that these two technologies will allow me to effectively carry out my objective for the project in testing the SCORM and xAPI E-Learning Standards.

Section 4: Project Proposal

Project Summary

Background

 The area I have chosen to base my project on is E-Learning. E-Learning plays a major role in the modern world. Whether it be training and upskilling employees in the business world, or educating the masses in colleges and schools in the educational world, E-Learning is at the centre of it. Through the research I conducted on the area of E-Learning, I was able to uncover that, when E-Learning content is being manufactured, it is generally done so in adherence to one of two main E-Learning standards. These two E-Learning standards are SCORM and Experience API (xAPI). Although, xAPI is a newer standard than SCORM, the SCORM standard is still used more when creating E-Learning content today.

Objectives

During this project, I plan to pit SCORM and xAPI against each other through two different pedagogies. I want to compare and contrast how both SCORM and xAPI perform when used to create these different pedagogies. The two pedagogies I will be using are:

- The first E-Learning pedagogy which I will be using to test SCORM and xAPI is Problem Based Learning. Problem Based Learning is a pedagogy which adopts a method of teaching where intricate real-world problems and issues are incorporated to promote and drive the learning of concepts and principles among students and employees, as opposed to directly presenting concepts and facts. Problem Based Learning content

can help develop and nurture learners' problem-solving abilities, communication skills and critical thinking skills while simultaneously providing opportunities for carrying out working in groups, the finding and evaluating of research materials and life-long learning.

- The second E-Learning pedagogy which I will be using to test SCORM and xAPI is Scenario Based Learning. Scenario Based Learning supports active learning strategies through the use of interactive scenarios. It generally requires users to gradually work through a story line scenario that is often based on a complex, or ill-structured issue that they are required to work through. Scenario Based Learning is based on the principles of situated learning theory and situated cognition. Situated learning theory puts forth the argument that learning best takes place in the context in which it is going to be used. Situated cognition holds the belief that knowledge is more fully understood and best acquired when it is situated within its context. Scenario Based Learning provides employees and students with experiences and opportunities that may be difficult for them to experience within the boundaries of a course, and works best when applied to tasks which require complex decision making.

My main objective is to determine which of the two standards performs better when used to create the Problem Based Learning Pedagogical E-Learning content and the Scenario Based Learning Pedagogical E-Learning content. In order to determine which standard performs better for each Pedagogy, both of the courses created for each Pedagogy will be evaluated under quality attributes which include:

- Accessibility

- Reliability

- Usability

- Responsiveness

Prototyping & Testing

I plan to use different technologies to create and host the different E-Learning courses. I will use iSpring Suite 8, an add on for PowerPoint, or Articulate, an independent E-Learning authoring application, to create SCORM and xAPI compliant courses. These courses will be created based on two different Pedagogies. These Pedagogies are Problem Based Learning and Scenario Based Learning. For each Pedagogy, a similar course will be created in adherence with each of the E-Learning standards. Once I have designed the complex Pedagogical content and published it once for SCORM and once for xAPI, I will then need a Learning Management System to host the E-Learning content which I created. It is at this time when I will host these courses on the SCORM Cloud Learning Management System. The SCORM Cloud has a built in Learning Record Store, which is required when attempting to do anything with the xAPI standard. This means that through the SCORM Cloud Learning Management System, I will be able to run and test both courses I have created for each Pedagogy.

Technical Requirements

The technical requirements to carry out this project are:

- iSpring Suite 8 – this can be used for creating the SCORM and xAPI compliant E-Learning content. iSpring Suite 8 is a plug in for Microsoft PowerPoint and helps
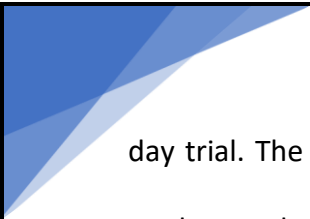
transform your slides into an effective and interactive E-Learning course. A free trial can be acquired of iSpring Suite 8 from their website.

- Articulate – this can be used for creating SCORM and xAPI compliant E-Learning content. Articulate is an independent E-Learning authoring tool which can be downloaded, as a free trial, from their website.

- SCORM Cloud – this is the Learning Management System which will be used to host the E-Learning content to allow for testing. SCORM Cloud is capable of hosting both SCORM and xAPI E-Learning content. SCORM Cloud also has a built in Learning Record Store, which is required when doing anything with the xAPI standard. A free SCORM Cloud account can be acquired with 100mb of storage.

Risk Assessment

One risk associated with this project is due to the fact that iSpring Suite 8 only comes in the form of a trial. This means once the trial runs out, I will not be able to create the E-Learning content anymore. However, there are multiple workarounds should this issue arise. The first workaround is to uninstall iSpring Suite completely, and then create a new email. I can then use this new email to gain access to another iSpring Suite trial. The other work around is to use a Windows 10 virtual machine for the E-Learning content creation process. I can use the virtual machine to acquire a trial of iSpring Suite 8, then when the trial expires, discard the virtual machine, and create a new one. This process can be replicated as many times as is needed. The same issue can arise if Articulate is required to create the E-Learning content. Articulate also comes in the form of a trial. However, it is a 30-day trial as opposed to a 14-

day trial. The workaround, or solution, to this issue is similar to that of the iSpring Suite 8 workaround. Due to the fact that Articulate would only be used to create the E-Learning content, a trial can be acquired and then, if it were to expire, there is the option to install it in a Windows 10 virtual machine and repeat the process as many times as required.

Another risk that can arise with this project comes from the SCORM Cloud Learning Management System. The 100mb storage may become an issue when I am hosting my courses on it. The work around to this issue, in the unlikely event that I max out my storage allowance, would be to simply select one of the pedagogical options and test both the SCORM and xAPI versions of the course fully, then remove them to make space for the new E-Learning content.

Project Methodology

Introduction

The project objectives will be achieved using iSpring Suite 8, or Articulate, and SCORM Cloud. I will choose one pedagogy at a time. I will design an elaborate course based on the Problem Based Learning Pedagogy and publish it one time for the xAPI E-Learning standard, and one time for the SCORM E-Learning standard. I will then design a complex course based on the Scenario Based Learning Pedagogy and will also publish this E-Learning course twice: one time for the xAPI E-Learning standard, and one time for SCORM E-Learning standard. Once I have successfully developed two complex and efficient E-Learning courses and have published each course twice for the two standards, I will host them on a Learning Management System. The Learning Management System I will use to host the E-Learning content is SCORM Cloud. SCORM Cloud can host both xAPI and SCORM content perfectly. Once I have successfully uploaded and hosted my four E-Learning courses on the SCORM Cloud, I will then be able to begin testing each course. I will divide the testing into two different areas by grouping the courses by Pedagogy. I will assess the Problem Based Learning Pedagogical content completely, testing and evaluating both the SCORM and xAPI E-Learning course version under quality attribute headings including reliability, usability, accessibility and responsiveness. I will then completely asses the Scenario Based Learning Pedagogical content, testing and evaluating both the SCORM and xAPI versions of the E-Learning course under quality attribute headings which include reliability, usability, accessibility and responsiveness. Once both Pedagogies have been fully assessed for both the SCORM and xAPI standards, I will then compare and contrast my findings in an attempt to uncover which E-Learning standard is a

better option for the Problem Based Learning Pedagogy, and which is the better option for the Scenario Based Learning Pedagogy. I will document all findings and results, and draw a conclusion which E-Learning standard suits which E-Learning Pedagogy best.

The potential problems with this project are the possibility of maxing the SCORM Cloud storage allowance, and running out of the iSpring Suite 8, or Articulate trials while still needing to create the E-Learning content. However, all of these issues have suitable and relatively easy workarounds.

Project Approach

The objective of this project is to help identify which E-Learning standard is better suited for Problem Based Learning, and Scenario Based Learning. The hope is that content creators will be able to use such information in order to better their E-Learning courses and content which use both of these Pedagogies.

I will create two different E-Learning courses, one for the Problem Based Learning Pedagogy, and one for the Scenario Based Pedagogy. I will then publish each course twice, one will be an xAPI compliant E-Learning course, and one will be a SCORM compliant E-Learning course.

All four pieces of E-Learning content will then be hosted on a Learning Management System, and tested and evaluated according to quality attributes which include usability, accessibility, responsiveness and reliability.

All findings and results will then be recorded and documented.

Project Plan

Project Phases

The first project phase will be all to do with the creation of the E-Learning content. I will begin by researching the methods to invoke in order to create both Problem Based Learning and Scenario Based Learning E-Learning courses successfully. I will then begin the creation process. First, I will create a complex Problem Based Learning E-Learning course. Once the course has been fully created, I will publish it twice. The first time will be in adherence with the SCORM E-Learning Standard, and the second time the course is published will be in adherence with the xAPI E-Learning standard. I will then create a full Scenario Based Learning E-Learning course and publish it once to be SCORM compliant, and once to be xAPI compliant.

Once all four courses have been created, I can move on to the second project phase. During the second project phase, the E-Learning courses will be hosted on a Learning Management System. The Learning Management System needs to be able to support both SCORM and xAPI content successfully so that testing can be carried out on the courses.

The third project phase involves the testing and evaluation of the E-Learning content. For testing purposes, the courses will be grouped by Pedagogies. Each pedagogy group will be taken, one at a time and assessed based on quality attributes such as reliability, accessibility, usability and responsiveness.

The final project phase is to document all results and conclude which E-Learning standard is best suited to which E-Leaning Pedagogy.

Deliverables and Milestones

The deliverables of this project will include four E-Learning courses based on two Pedagogies and two E-Learning standards, and a detailed report containing information on all project phases and all test results. The report will be used to indicate which E-Learning Standard, whether it be SCORM or xAPI, suits which Pedagogy, Problem Based Learning and Scenario Based Learning, best.

Gantt Chart

Figure 1: Gantt Chart of 4th Year Project Plan

Conclusion

The value of this project is being able to determine which E-Learning Standard, be it SCORM or xAPI, is the best option to choose when creating an E-Learning course based on the Problem Based Learning Pedagogy, and which is the best standard to choose when creating an E-Learning course based on the Scenario Based Pedagogy.
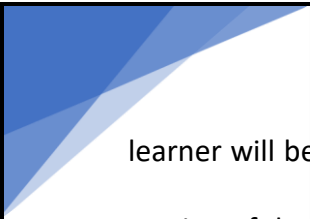
All that is required in order to execute this project is an E-Learning authoring tool, such as iSpring Suite 8 or Articulate, and an E-Learning Learning Management System which is capable of hosting SCORM and xAPI compliant E-Learning content, such as SCORM Cloud. Both the E-Learning authoring tools and the E-Learning LMS can be acquired free of charge and do not require any payment as time goes on.

Section 5: Iteration 1

Prototype Plan

Project Overview & Target Audience

This project is based on the area of e-learning. The aim of this project is to compare the two most used e-learning standards, SCORM and xAPI, through the use of two different pedagogical philosophies, Problem Based Learning and Scenario Based Learning. There will be three different use cases for this project. Metrics such as accessibility, responsiveness, reliability, effectiveness, usability, along with user experience feedback will be evaluated for each use case. The first use case will be a Problem Based Learning e-learning course, the second use case will be a Scenario Based Learning e-learning course, and the final use case will be an e-learning course which incorporates both the Scenario Based Learning, and the Problem Based Learning pedagogical framework. Each use case will be published twice using an e-learning authoring tool. The first time a use case is published, it will be in adherence with the SCORM e-learning standard. The second time a use case is published, it will be in adherence with the xAPI e-learning standard. In total, there will be six e-learning courses which will be hosted on an online Learning Management System. Two different user groups of four learners will be created on the online Learning Management System. Each group will contain two subgroups. The first subgroup will be assigned the SCORM version of a course, with the second subgroup being assigned the xAPI version of that same e-learning course. This process will occur for the Problem Based Learning and Scenario Based Learning individual courses. The final course, a combination of Problem and Scenario Based Learning will be assigned to two different members, each being from a different user group. Once again, one

learner will be assigned the SCORM version of the course, with the other receiving the xAPI version of the course.

The target audience for this project are e-learners themselves, and e-learning administrators. E-learners refers to the learners who engage in online courses and learning activities. E-learning administrators are the people who are responsible for creating new e-learning content, and assigning that new content to e-learners.
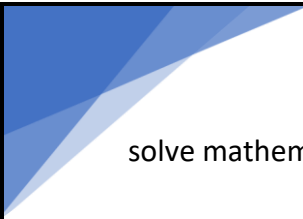
User Stories

For this project there will be three different user stories. The first user story will be a Problem Based Learning course, the second will be a Scenario Based Learning Course, and the third and final user story will be a e-learning course which incorporates elements of both Problem and Scenario Based Learning. The acceptance criteria for this story is whether the course can be successfully hosted on an online LMS and record information from the learners that engage with it.

The first user story is a Problem Based Learning course centred around the area of Networking. This course will have four different sections and a graded exam at the end.

The second user story is a Scenario Based Learning course based on good work ethics. This course will have four scenarios and the action that the learner chooses in each scenario will be graded. The acceptance criteria for this story is also whether the course can be successfully hosted on an online LMS and record information from the learners that engage with it.

The third user story will be a course which uses Problem Based Learning and Scenario Based Learning pedagogies. This course will be a shopkeeper scenario that will require the user to

solve mathematical questions based on the customers they are dealing with. Once again, the acceptance criteria this course is whether it can be successfully hosted on an online LMS and record user engagement information.

Prioritising Stories

As the main objective of this project is to compare SCORM and xAPI using courses that adopt the Problem Based Learning and Scenario Based Learning pedagogical approaches, the user stories with the individual pedagogies will have higher priorities than the user story which uses elements of both pedagogies.

Problem Based Learning is a more commonly used pedagogical approach than Scenario Based Learning. Therefore, designing a Problem Based Learning e-learning course with SCORM and xAPI e-learning standards has the highest priority. This means that user story number 1 will have a priority of 1. Creating a Scenario Based Learning course adhering to SCORM and xAPI e-learning standards will have the second highest priority. Therefore, the second user story will have a priority of 2. Finally, the course based on a combination of the Problem Based Learning and Scenario Based Learning pedagogies will have the third highest priority, meaning the third user story will have a priority of 3.

Estimated Implementation Time

User story 1 involves the Problem Based Learning course. Due to the course containing four different sections and the need to design the appearance of the slides, populate the slides with information, ensure correct information is being presented to the user and design and

implement multiple problems, the estimated time to build this course and host a SCORM version, and an xAPI version on an LMS is approximately a total of 10 hours.

User story 2 involves the Scenario Based Learning course. This course will contain 4 different realistic workplace scenarios which require ethical responses from the user throughout. This course will require the planning and designing of different scenarios. In depth feedback will also be created for each scenario which will explain why one action is more ethical than the other. The estimated time for implementation for this user story is a total of 8 hours.

The third user story requires the creation of a course using both the Problem and Scenario Based Learning approaches. This course will contain a shopkeeper scenario that will require mathematical problems to be worked out throughout the course. Through the building of the course, designing the slides and populating them with necessary information and providing feedback and corrections all throughout the user's attempt at completing this course, the estimated time of implementation for this user story is a total of 7 hours.

Technical Options

The Learning Management System which will has been chosen for this project is the SCORM Cloud LMS, and the e-learning authoring tool which has been selected is Articulate 360.
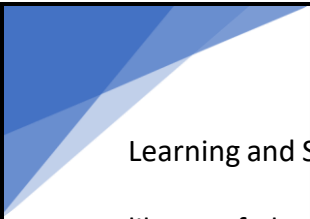
Four different LMSs were tested and evaluated for use during this project. These four LMSs are Docebo, ProProfs Training Maker, Moodle Cloud SCORM Cloud. Out of these 4 LMSs, SCORM Cloud was the best option. SCORM Cloud is the only LMS, out of the 4, that was capable of support both the SCORM and xAPI e-learning standards while also offering a free subscription with no expiry date. Docebo and ProProfs Training Maker were both 30-day

trails which meant that, when the trial ran out, the user would lose all course and user data that was previously stored in their online LMS. While MoodleCloud also provided a full-time subscription, its limitation was that it could only host e-learning content published with the SCORM standard. Furthermore, whenever the xAPI standard is being used, a Learning Record Store is required. Learning Record Stores are needed to record information about xAPI content and are separate to Learning Management Systems. However, SCORM Cloud contains a built in Learning Record Store, and was the only LMS to have such a feature. SCORM Cloud allows users with a free subscription to create up to 10 learner accounts and store up to 100MB worth of e-learning content. SCORM Cloud proved to be the best LMS to utilise for this project.

Two different e-learning authoring tools were tested to determine which tool is the best option for the project. The two authoring tools that were tested are iSpring Suite 8 and Articulate 360. Articulate is an independent E-Learning authoring tool while iSpring Suite is a plug-in for Microsoft PowerPoint. These tools were chosen due to the fact that they are both capable of creating SCORM and xAPI e-learning content. Articulate was chosen over iSpring Suite for multiple reasons. While both tools are only trial versions, the Articulate trial is double that of iSpring Suite with a trial period of 60 days. Articulate proved to be much more flexible. With Articulate, you can create multiple different scenes. There can be graded questions throughout these scenes at different points. A single results slide can be shown at the end for all questions. With iSpring Suite, there is no flexibility in how you examine users. All graded questions must appear one after the other as, if there are questions randomly placed throughout a course, iSpring will not be able to provide a single result for that course as each question will appear as a separate test which is very inefficient when creating Problem Based

Learning and Scenario Based Learning courses. Furthermore, Articulate provides an extensive library of photos, illustrations, characters and a wider range of question types to help create intricate courses, exams and settings which iSpring Suite does not. Therefore, Articulate is the more appropriate authoring tool to use for this project.
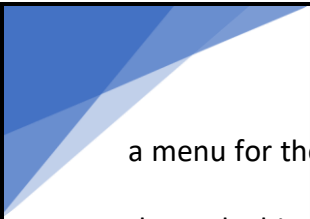
Development of Initial Prototype

The first thing that was required was the creation of user groups. Two user groups, each containing for people were created. One group will be engaging the first user story, while the other user group engages in the second user story. Inside each group, there are two subgroups. One subgroup will be assigned the SCORM version of a course, with the other subgroup receiving the xAPI version of the course. For the third user story, two users, one from each user group, will be assigned the SCORM and xAPI versions of the course respectively. The user groups were selected and created with the objective of providing new content to the learners.

Once all user stories have been created using Articulate Storyline 360, they will be published twice, one time for each standard, and hosted on the SCORM Cloud Learning Management System. Once on the SCORM Cloud LMS, courses will be assigned to users.

User Story 1

As the first user story had the highest priority, it was created first. User story 1 was the Problem Based Learning course. This course was an introductory course to the topic of Networking. Four different sections on networking were designed, with a fifth section being an exam on the contents of the course. The four sections were Networks, Hardware, Types of Networks and Addressing. At the end of each section, there is a non-graded question which can be attempted unlimited times. This question is to help ensure that the learner is maintaining the information they have just engage with. It was decided that there would be

a menu for the course navigation. A button was added for each section including the quiz at the end. This main menu links to all sections of the course, and, within, each section there is a submenu which also contains a link back to the main menu. This allows learners to freely navigate the course and choose their own starting points, and decide in which order they wish to learn each Networking topic. A scene was created in Articulate for each section with scene 1 being the main menu.

Scene 2 is the 'Networks' section of the course. Within this section there is a submenu which links to two different slides which explain to a user what a network is and why are networks important.

Scene 3 is the 'Hardware' section. This section contains images of, and information on networking hardware including routers, switches, hubs and wireless routers.

Scene 4 is the 'Types of Networks' section which introduces learners to Local Area Networks, Wide Area Networks and Wireless Local Area Networks. There is information on each type of network along with an image of the type of network implemented in packet trace in order to emphasise to the learner how these networks operate.

Scene 5 is the last informative section of the course. This section is the 'Addressing' section. This section aims to inform learners regarding IP addresses, MAC addresses, Subnet Masks, and the Network and Broadcast addresses of a network.

Scene 6 is the final section of this Problem Based Learning course. This section contains the exam. The exam contains 10 questions in total. Question types such as 'matching drag and drop', 'true or false', 'fill in the blank', 'multiple choice' and 'multiple response' were used for the exam questions. At the end of the exam, there is a result slide which provides the learner

with their grade for the course while indicating whether they have failed or passed. There are also two buttons on the results slide. The first button allows users to review the exam so that they can read through feedback and explanations as to the correct answer for each question. The second button is a link to a user experience survey through which they can leave feedback on the course such as their overall satisfaction with it, whether the course was easy to navigate and also provide any comments or suggestions they may have for the course.

Once the building of the course was complete, it was published one time for the SCORM e-learning standard, and one time for the xAPI e-learning standard.

Figure 2: Networking Course - User Story 1

User Story 2

The second user story had the second highest priority. This user story was the Scenario Based Learning e-learning course. This course contained four different scenarios with the objective of encouraging good work ethics. Each scenario utilised an appropriate backdrop along with different characters to help push the narrative of each scenario. The learner's response to

each scenario will be graded, and an in-depth explanation as to why one option is better than the other will be provided for each scenario in the review section at the end of the course.

It is scene 2 when the first scenario begins. This scenario begins with the learner beginning their new job in a major technology organisation. The learner holds a position in the organisation's IT Department and is tasked with troubleshooting a friendly colleague's laptop. Whilst troubleshooting the laptop, the learner discovers that their colleague has been using the organisation's laptop to illegally download music and movies. The learner must then decide which action to take.

Scene 3 involves a scenario where the learner has been moved to a project team to help work on a major new product which is being developed. The learner engages with their friend, who works for one of their organisation's competitors, and must decide whether or not they should tell their friend about the new project they have been assigned to.

Scene 4 involves a scenario in which learner has made an error whilst compiling a customer engagement survey master list. The learner does not realise the mistake until the deadline has passed and is worried about the ramifications for such an error. The learner must make a decision regarding which action they wish to take.

Scene 5 contains a scenario in which the learner's organisation is upgrading equipment and appears to be recycling their old computer equipment. The learner is in a scenario where they wish to bring home an old computer monitor and must choose what they feel is the best option to take in order to try and obtain the monitor.

The final scene contains a result and feedback slide. The user will receive a result for the course based on the actions they chose in each scenario. There will also be an option to review

each scenario which will provide in-depth feedback, and a link to take a user experience survey in relation to the course.

Once the creation of this scenario course was complete, it was published one time for the SCORM e-learning standard, and one time for the xAPI e-learning standard.
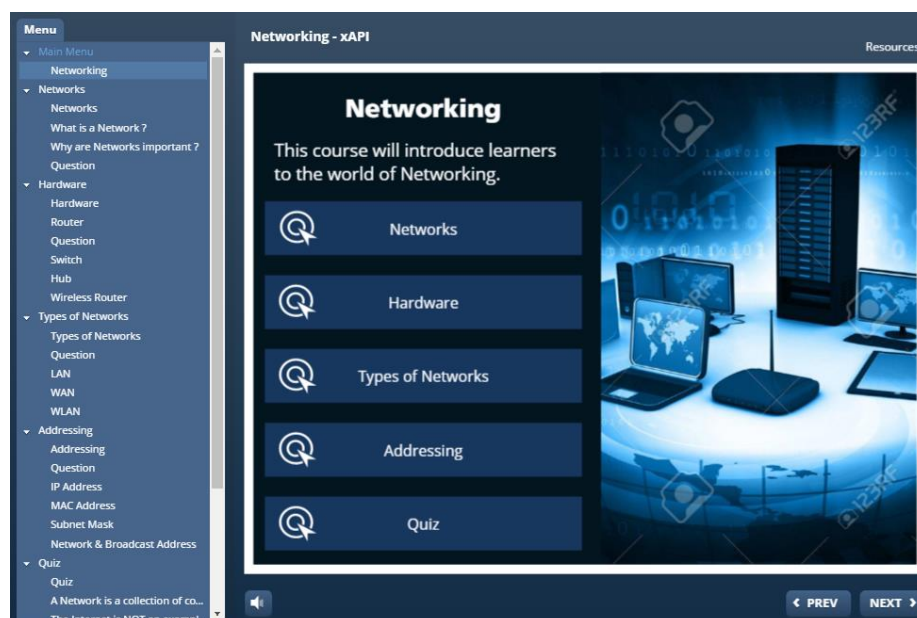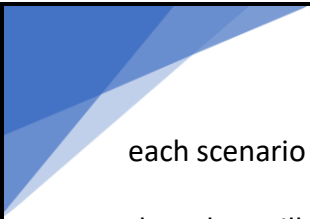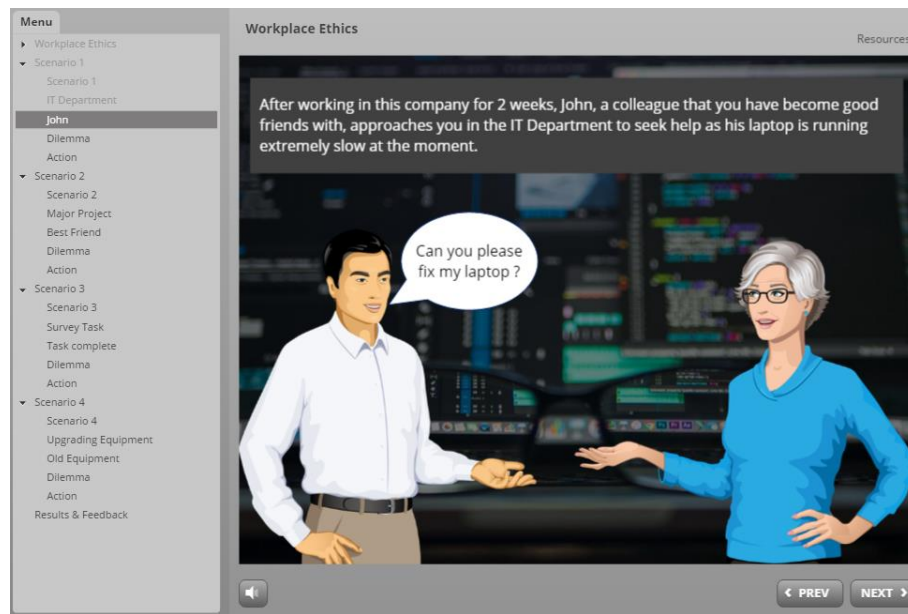

Figure 3: Work Ethics Course - User Story 2

User Story 3

The final user story was an e-learning course which adopted both Problem Based Learning and Scenario Based Learning pedagogical approaches. A shopkeeper scenario was implemented for this course. The learner commands the role of the shopkeeper, and must solve mathematical calculations based on the customer's transaction for each slide. A supermarket setting was designed using the illustration features provided by Articulate, along with the character features. This course also contains 8 graded questions.

This course takes place in a single scene. The first slide is the title page, which also provides

an explanation of the course and instructions as to the course works. For each question, the learner is required to understand which products the customer is going to be purchasing, returning, or exchanging, calculate the total cost of the customer's transaction, and add it to the current balance in their cash register. Item prices can be revealed through a clickable menu button which will contain, the name and illustration of the item along with their price. Once the learner believes they have calculated the cash register balance, they must enter it into the text field and submit their answer. If a user answers the scenario problem incorrectly, they will immediately receive feedback, indicating what the correct values of items are and showing the correct new cash register balance. They will then move on to the next question. The correct new cash register balance will carry over into each scenario that follows, increasing or decreasing as appropriate. This is why, if a learner has gotten a question wrong, they are shown the correct answer straight away so they can continue completing the course. Once all scenario problems have been answered, there is a result slide which will provide a user with a grade for the course. This result slide also contains a review button which will take the user through each scenario, indicating clearly, how each cash register balance value was obtained. This allows users who input incorrect answers to compare their own calculations with the correct calculations so that they understand how and where they made errors with their calculations. There will also be a button which will link the learner to a user experience survey so they can review the course and provide any comments on or suggestions for the course.

Once all the problems had been designed for this shopkeeper scenario, the course was published one time in adherence with the SCORM standard, and one time in adherence with the xAPI standard.

Figure 4: Mathematics - Shopkeeper Scenario – User Story 3

Once all user stories had been fully developed using the Articulate Storyline 360 authoring tool and published for each standard, they were uploaded to the SCORM Cloud online LMS. The courses where then assigned to the users.

User Group 1 was assigned the Problem Based Learning Networking course. More specifically, Group 1A were assigned the xAPI version of the Networking course, and Group 1B were assigned the SCORM version of the Networking course.

User Group 2 were assigned the Scenario Based Learning Work Ethics course. Group 2A were assigned the xAPI version of the Work Ethics course, with Group 2B receiving the SCORM version of the Work Ethics course.

For the Problem Based Learning and Scenario Based Learning Mathematics – Shopkeeper Scenario course, two different learners were chosen. One learner was assigned the xAPI version of the course, with the second learner receiving the SCORM version of the course.

Figure 5: Courses Hosted on SCORM Cloud LMS

Accessibility

E-Learning accessibility refers to the ability of generating and providing e-learning opportunities which are accessible to everyone. Users were able to access their SCORM Cloud learning hubs with ease. Due to configurations while creating the courses, all e-learning courses which were published, whether SCORM or xAPI courses, could be accessed from anywhere, using computers, tablets and smartphones. No user reported any issue when trying to access their prescribed e-learning course.

Responsiveness

While accessibility refers to users possessing the ability to access content anytime, anywhere, on any device, e-learning responsiveness is about ensuring that the content which is accessible across different devices, is presented in an appropriate format. The e-learning content must resize to meet the dimensions of the user's device in order to create for an optimal viewing and learning experience. Both the SCORM and xAPI versions of each course were tested on mobile devices, and tablets, as well as the standard computer approach. For the smaller touchscreen tablets and mobile phones, the courses resized to an appropriate format and also added functionality for the user to navigate the course through swiping the screen. The drag and drop questions in the Networking course, the text box answers in the Mathematics course, and the choosing of an action in the Work Ethics course all worked correctly on the smaller, touchscreen devices as well as on computers and laptops. No

features were rendered unusable when courses had to be resized to fit a particular screen.

User Experience
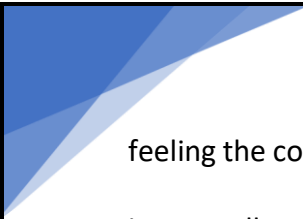
The user experience survey was used to determine many factors about the courses.

Usability is the extent to which e-learning content has been designed with effectives and satisfaction in mind, and is used for the purpose it was created for.

For the Networking course, the overall user satisfaction was split 50:50 with 2 users rating the course as good (score of 4), and two users rating the course as excellent (score of 5). This gave the Networking course satisfaction an average score of 4.50. All four users passed the course. The two users who felt the course was excellent, achieved scores of 60% and 70% respectively, with the two users who rated the courses as good, achieving final results of 70% and 80% respectively. To determine how effective the course was for the users, they were asked whether they felt the topics covered were relevant to the objective of the course, and whether the content was clear and easy to understand. In response to relevant topics, users were split 50:50 once again, in the exact same manner, for agree (score of 4) and strongly agree (score of 5) giving the course relevancy an average score of 4.50. Regarding the course content being clear and easy to understand, the user who achieved the highest result in this course, responded with neutral (score of 3), one user agreed, while the two other users strongly agreed. This gives the course a rating of 4.25 regarding the material being clear and easy to understand. Therefore, the average score of the course effectiveness is 4.375 from 4 users which leads to a usability score of 4.44.

The Work Ethics scenario course received an overall satisfaction score of 4.25, with one user

feeling the course was average (score of 3), one user feeling it was good, and two users rating it as excellent. All users passed the course. To determine the effectiveness of this course were asked to strongly disagree (score of 1), disagree (score of 2), neutral response (score of 3), agree (score of 4) or strongly agree (score of 5) to questions of whether or not the scenarios were realistic and well thought out, and if the message and intention of this course was clear. The scenarios received an average score of 4.25 with one user responding with neutral, one user agreeing that they were realistic and well thought out, and two users strongly agreeing. Two users agreed that the message of the course was clear, while two users strongly agreed that the message of the course was clear giving the course clarity a score of 4.50. This means that the overall effectiveness of the course received a score of 4.375 from 4 users resulting in a usability score of 4.31.

The Mathematics – Shopkeeper Scenario course received an overall user satisfaction score of 4.00. One user passed this course, while the other user failed this course. The user who failed the course gave a satisfaction grade of average (score of 3), while the user who passed the course gave a satisfaction grade of excellent (score of 5). To determine the effectiveness of this course users were asked whether the scenario calculations were complex, and whether their learning was facilitated well through prompt feedback highlighting to them where they went wrong, and what the correct answer is. One user strongly agreed, while the other merely agreed that the calculations were challenging, giving an average score of 4.50. Both users agreed that their learning was facilitated well through prompt and efficient feedback, resulting in a score of 4.00. Therefore, the effectiveness score for this course was 4.25 leading to a usability score of 4.38.

Navigation is a crucial element in ensuring an engaging e-learning course. The Networking

course used a 'main menu' navigation format which allowed users the freedom to choose their own route to complete the course. The ease of navigation for this course received an average score of 4.50 from users, with three users giving it a rating of 5, and one user rating the navigation with a score of 3. The user who provided a rating of 3 regarding the difficulty of navigating the course commented that, while it was a positive thing that they could choose where to start the course, navigating back to the main menu at the end of each section was slightly tedious. The Work Ethics course used standard navigation and received an average user score of 4.75 with three ratings of 5 and one rating of 4. Due to the nature of continuation and progression that was built into the Mathematics course, the course used restricted navigation which meant that users could not choose where to start or skip, or move, to other slides until they had answered the scenario problem. It was a linear navigation system.

All users were asked as to whether or not they would recommend this course. All four Networking learners said they would recommend this course to people who wish to get an introduction into Networking. Similarly, the Work Ethics, and Mathematics, learners, all said they would recommend their respective courses to others.

Users were also asked to provide any feedback or suggestions they may have for the courses going forward into iteration 2. The key points from the users' feedback are that the Networking navigation may need to be redesigned so as to not require unnecessary effort and consume more time from users, the Work Ethics scenarios were good and well thought out but may need to be more intricate and complicated, it may be a good idea to add more scenarios to the Work Ethics course, and the Mathematics course could be improved by adding more questions and a larger product catalogue.

Recorded Information

For both SCORM and xAPI courses, SCORM Cloud records the learner ID, learner name, the learner's completion status for a course, the success status of the learner, i.e. whether they have passed this course or failed it, the score they achieved in the course and the total time it took them to complete the course. This basic information can be found in a courses information page and can exported to a csv file.

Create Date	Learner Id	Learner Name	Completion	Success	Score	Total Time (seconds)
2/20/18 5:18 PM	colmbyrne44@gmail.com	Colm Byrne	complete	passed	70	1465
2/20/18 5:18 PM	rayjuthan@hotmail.com	Ray Juthan	complete	passed	80	1692

Figure 6: The SCORM version of the Networking course's user reportage in csv format.

However, it is in SCORM Cloud's Learning Record Store where more in-depth data is recorded and can be reviewed.

For the SCORM version of the Networking course, SCORM recorded information such as when a user had completed the course, with what score they finished the course with, and for exams questions, SCORM records whether the question was correctly answered, what was the question type, and what scene and slide number the question occurred.

2018-02-20T18:40:47.390	Ray Juthan correctly answered 'Question Scene6_Slide11_TrueFalse_0_0' with response 't'
2018-02-20T18:40:47.389	Ray Juthan correctly answered 'Question Scene6_Slide10_MultiResponse_0_0' with response 'a,a'
2018-02-20T18:40:47.388	Ray Juthan correctly answered 'Question Scene6_Slide9_MultiChoice_0_0' with response 'a'
2018-02-20T18:40:47.387	Ray Juthan incorrectly answered 'Question Scene6_Slide8_MatchingDragDrop_0_0' with response '0.i,1.s,2.m,3.n,4.b'
2018-02-20T18:40:47.386	Ray Juthan correctly answered 'Question Scene6_Slide7_MultiChoice_0_0' with response 'w'
2018-02-20T18:40:47.384	Ray Juthan correctly answered 'Question Scene6_Slide6_TrueFalse_0_0' with response 't'
2018-02-20T18:40:47.383	Ray Juthan incorrectly answered 'Question Scene6_Slide5_FillInTheBlank_0_0' with response '192.168'
2018-02-20T18:40:47.382	Ray Juthan correctly answered 'Question Scene6_Slide4_TrueFalse_0_0' with response 'f'
2018-02-20T18:40:47.381	Ray Juthan correctly answered 'Question Scene6_Slide3_MatchingDragDrop_0_0' with response '0.r,1.s,2.w,3.h'
2018-02-20T18:40:47.380	Ray Juthan correctly answered 'Question Scene6_Slide2_TrueFalse_0_0' with response 't'
2018-02-20T18:40:47.379	Ray Juthan completed 'Networking - SCORM' with score 80%

Figure 7: All SCORM Networking Course recorded information.

For the xAPI version of the Networking course, xAPI was able to record information including, when the course was launched, when the learner accessed a slide, and what the name of that slide is. In regards, to exams, xAPI records when the user has started the quiz, what is the name of the question they are on, what their response to the question was and how many marks they obtained from that question. It also records when the user has received their results, and when and whether they have reviewed their graded answers to see the feedback that was designed for them. Finally, it also shows when the user has finished the course completely, whether they have passed the course and with what percentage.

2018-02-21T15:01:09.822	Jonathan Doyle experienced 'An IP address is comprised of a host portion and a network portion. What is the network portion of a 192.168.10.123 IP address ?'
2018-02-21T15:01:07.163	Jonathan Doyle experienced 'The Internet is NOT an example of a Network.'
2018-02-21T15:01:02.118	Jonathan Doyle experienced 'An IP address is comprised of a host portion and a network portion. What is the network portion of a 192.168.10.123 IP address ?'
2018-02-21T15:00:58.158	Jonathan Doyle incorrectly answered 'The Internet is NOT an example of a Network.' with response 'choice_6Cr8Mf5hnWC' with score 0
2018-02-21T15:00:45.810	Jonathan Doyle experienced 'The Internet is NOT an example of a Network.'
2018-02-21T15:00:44.346	Jonathan Doyle correctly answered 'Match the network hardware to the correct description.' with response 'statement_68RfRkxxPkj[.]cho...' with score 10
2018-02-21T14:59:42.311	Jonathan Doyle experienced 'Match the network hardware to the correct description.'
2018-02-21T14:59:40.502	Jonathan Doyle correctly answered 'A Network is a collection of computers, servers, mainframes, network devices, peripherals, or other devices which are all connected to one another to allow the sharing of data.' with response 'choice_5o5ELUejLs6' with score 10
2018-02-21T14:59:35.267	Jonathan Doyle experienced 'A Network is a collection of computers, servers, mainframes, network devices, peripherals, or other devices which are all connected to one another to allow the sharing of data.'
2018-02-21T14:59:32.542	Jonathan Doyle experienced 'Quiz'
2018-02-21T14:59:30.200	Jonathan Doyle experienced 'Addressing'
2018-02-21T14:59:24.086	Jonathan Doyle experienced 'Question'
2018-02-21T14:59:22.718	Jonathan Doyle experienced 'Addressing'
2018-02-21T14:58:39.705	Jonathan Doyle experienced 'Network & Broadcast Address'

Figure 8: Recorded information from xAPI Networking Course.

For the SCORM version of the Work Ethics course, SCORM was able to record when the learner started the course, what percentage they finished the course with, an indication that they have responded to the question, what slide the question was on and it indicates whether

the answer to the question was correct or incorrect.

Figure 9: Recorded information from the SCORM Work Ethics Course.

The xAPI version of the Work Ethics course recorded when the user launched the course, when the user accessed each slide, the name of the slide accessed, the user's response to each scenario dilemma, the score the user received for their choice, when they had finished the course, if they reviewed their answers to obtain feedback, and what percentage score they finished with and whether that percentage means they have passed or failed the course.

Figure 10: Recorded information from the xAPI Work Ethics course.

With the SCORM version of the Mathematics – Shopkeeper Scenario course, SCORM recorded when the course was completed and what percentage the user received for the course. SCORM also recorded the scene and slide number of each question and with numeric answer the user entered for the cash register balance.
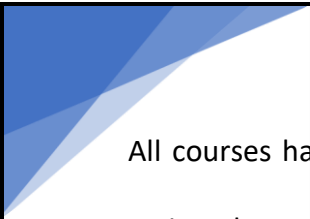
2018-02-20T23:01:55.431	Sharon Juthan correctly answered 'Question Scene1_Slide9_Numeric_0_0' with response '205.87'
2018-02-20T23:01:55.430	Sharon Juthan correctly answered 'Question Scene1_Slide8_Numeric_0_0' with response '169.55'
2018-02-20T23:01:55.429	Sharon Juthan correctly answered 'Question Scene1_Slide7_Numeric_0_0' with response '153.57'
2018-02-20T23:01:55.428	Sharon Juthan correctly answered 'Question Scene1_Slide6_Numeric_0_0' with response '153.57'
2018-02-20T23:01:55.427	Sharon Juthan correctly answered 'Question Scene1_Slide5_Numeric_0_0' with response '150.02'
2018-02-20T23:01:55.426	Sharon Juthan correctly answered 'Question Scene1_Slide4_Numeric_0_0' with response '132.84'
2018-02-20T23:01:55.425	Sharon Juthan incorrectly answered 'Question Scene1_Slide3_Numeric_0_0' with response '138.54'
2018-02-20T23:01:55.423	Sharon Juthan correctly answered 'Question Scene1_Slide2_Numeric_0_0' with response '113.94'
2018-02-20T23:01:55.422	Sharon Juthan completed 'Mathematics - Supermarket Scenario (SCORM)' with score 88%

Figure 11: Recorded information from the SCORM version of the Mathematics course.

From the xAPI version of the Mathematics course, xAPI recorded when the user launched the course, each time they accessed a slide and what the name of that slide was, what numeric value they answered the question with, if that answer was correct, or incorrect, and how many marks were awarded for either the wrong or right answer to that question. It also records whether the user chose to review their answers at the end of the course, and whether they have failed or passed the course and with what percentage.

2018-02-20T18:29:59.921	Cody Juthan failed 'Mathematics - Supermarket Scenario (xAPI)' with score 25%
2018-02-20T18:29:59.543	Cody Juthan experienced 'Results Slide'
2018-02-20T18:29:54.756	Cody Juthan incorrectly answered 'Numeric' with response '204.87' with score 0
2018-02-20T18:27:39.305	Cody Juthan experienced 'Customer 8'
2018-02-20T18:27:36.083	Cody Juthan incorrectly answered 'Numeric' with response '168.95' with score 0
2018-02-20T18:25:52.687	Cody Juthan experienced 'Customer 7'
2018-02-20T18:25:47.219	Cody Juthan correctly answered 'Numeric' with response '153.57' with score 10

Figure 12: Recorded information from the xAPI version of the Mathematics course.

All courses had the ability to be successfully hosted on the online SCORM Cloud LMS and assigned to users. Once the users began to engage with the courses, information was successfully recorded from their attempts of each course.

Recommendations for Next Iteration

The navigation on the Networking course will need to be updated. It did not operate as fully intended, as in some cases it was linking to the next slide in the sequence when it was supposed to return to the menu. The 'main menu', which some learners had issues with could be redesigned to appear at the end of each section instead of forcing more clicks from the user. E-learning efficiency is all to do with helping learners reach goals with the fewest possible clicks. The aim with the Networking course would be to make it more efficient for learners. This is an issue that will be corrected moving forward towards the next iteration.

The Work Ethics course, which all users found realistic and well thought out, needs more scenarios and more possible actions to take in each scenario. There might be a possibility of having scenarios that go deeper, i.e. when an action is chosen, the scenario doesn't just end there, more options pop up based on the first action choice. There may be multiple layers to each scenario action. The Work Ethics course will be upgraded moving forward.

Regarding the Mathematics course, moving forward, there should be a larger catalogue of items for use in each scenario to avoid too much repetitiveness regarding what each customer is purchasing. The number of problems to solve should also be increased to facilitate use of the new products which will be added to the catalogue inside the course.

There is a vast difference in the type, and amount of information that the SCORM and xAPI

e-learning standards have recorded for each learner's attempt at the e-learning courses they took part in. This is an area that should be examined further when moving forward with the second iteration of this project.

Section 6: Iteration 2

User Story 1

The first user story was the Problem Based Learning course based on the area of Networking.

In iteration 1, 25% of the user group which participated in this course found it a difficult course

to navigate. Along with being difficult to navigate, the menu-style navigation also raised

concerns regarding efficiency. The concept of E-Learning efficiency was mentioned in

iteration 1. E-Learning efficiency is all about ensuring that the learner reaches their e-learning

objective or goal in as few clicks as possible. Upon review of the Networking course, it was

determined that the menu-style navigation was inefficient. The menu-style navigation forced

the learner to click a total of 54 times in order to complete the course. The navigation was

redesigned to be a straight-forward course navigation. Rather than having to click back to a

main menu throughout the course and navigate to different sections themselves, the course

now only requires the user to click the "next" and "prev" buttons to progress. This proved to

also be a much more efficient solution as now the course will only take the learner 27 clicks

to complete it which is a reduction 50% compared to the number of clicks required for the Networking course that was assigned to user groups in iteration 1.
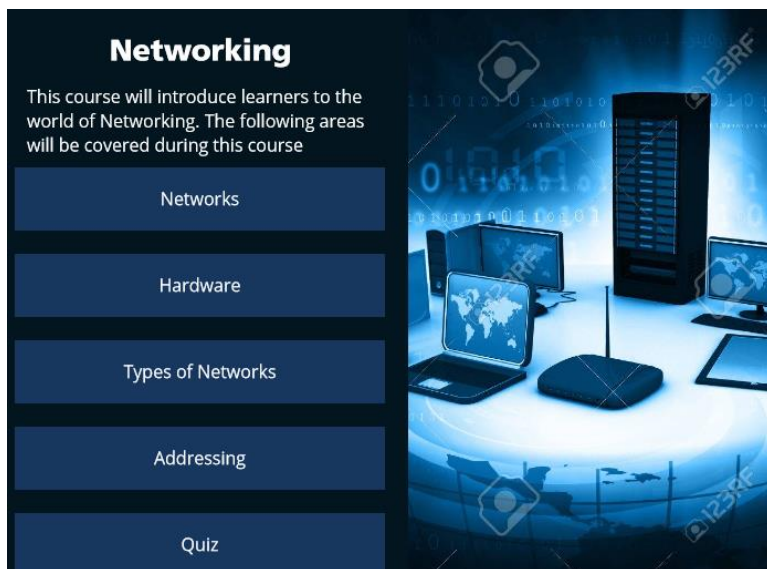
Figure 13: New Intro Screen for Networking Course is no longer a menu.

The Networking course, not including the exam at the end, contained four main sections: Networks, Hardware, Types of Networks and Addressing. Within each of these sections, there was a single non-graded question at the end specific to that section. These questions were put in place in order to facilitate learning for the learner and ensure they were focusing when working through the section, and retained some information about that section. These questions were programmed to allow the learner to attempt them an unlimited number of times. Within the Networking course assigned for iteration 1, there were no hints provided to help learners who could not get the right answer progress. To facilitate this, for iteration 2, the try again tab, which would pop up upon the submission of an incorrect answer, was edited to also contain some useful hints to help the learner answer the question correctly.

Figure 14: Non-graded questions at the end of each section now have hints for learners.

Finally, the quiz for the Networking course was also redesigned. Originally, in iteration 1 the course contained a linear exam comprised of 10 different questions. For the second iteration, the quiz was redesigned to have two different branches of 8 questions. Which branch the

learner followed was determined by their response to the very first question in the exam. This question was a relatively easy to answer correctly, however, it was based on content from the very first slide of information. Therefore, if a learner answers this question correctly, it implies that they are good at retaining information. If a learner gets this first question wrong, the interpretation is that perhaps they have forgotten the information and may find it difficult to retain information in general. Therefore, should a learner get the first question correct, they will be pushed down branch A which will contain more intricate and difficult questions that those in branch B, which is the branch that learners who get the first question incorrect will be pushed down.
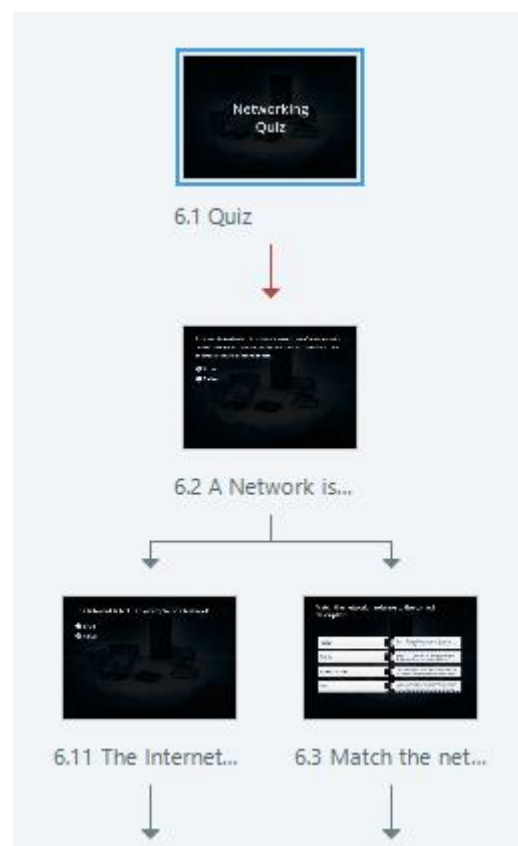
Figure 15: Exam for Networking Quiz Branches.

User Story 2

The second user story was the Scenario Based Learning Work Ethics course which walked learners through different scenarios which they may experience during their time in employment. In iteration 1, a common recommendation for this course was to include an additional scenario and have more in-depth scenarios that didn't only provide the user with option A and option B when deciding which action to choose.

In the Work Ethics course which was assigned for iteration 1, there were 4 different scenarios. Each scenario attempted to place the user in a particular environment, provide a story for the scenario, and provide some background and context about the situation. The 4 different work ethics which were covered were blowing the whistle, upholding confidentiality agreements, taking responsibility for your actions and your work, and not stealing from your organisation. For the second iteration, a fifth scenario was designed with the goal of emphasising the need to stay professional at all times, regardless of the situation you are in with a customer.

They inform you that they opened a support ticket last week and the issue still has not been resolved nor have they received any contact from the Product Support team about the issue. It becomes clear that the customer is taking out all of their frustration on you even though this is your first meeting with them.
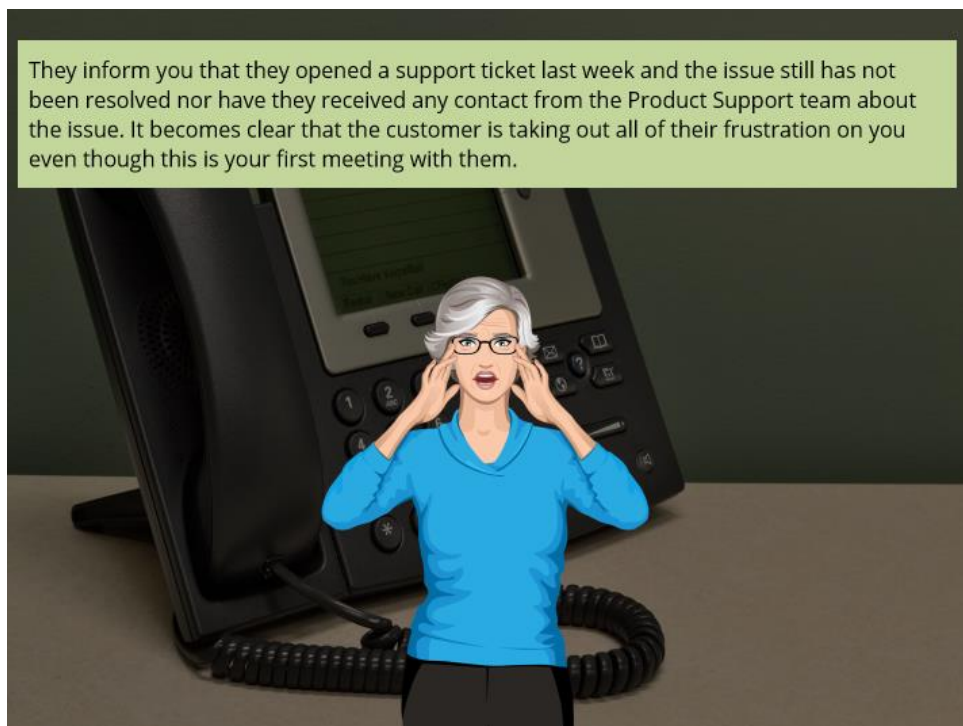
Figure 16: Scene from the new scenario.

Attempting to make more in-depth scenarios, with multiple layers of choices was no easy task. For the first attempt, the course was left as it, and new slides were added after the original choice. By choosing the correct choice initially, the user would receive the incorrect popup and be moved to the next scenario. If a user chose correctly, the correct popup would be hidden and the user would jump to the next slide which continued the scenario with more options. The process would continue until the end of the scenario. This method was implemented for all of the scenarios. While this scenario method did work with regards to adding more layers to the scenario choices, it caused an issue when a user wanted to receive feedback and review the scenarios. Due to the fact that the question forms' functionality, which originally just triggered a correct or incorrect popup, had been altered to, if the choice was correct, jump to a new set of choices, when reviewing the scenarios, the player did not know where to go to get the feedback which was designed for each scenario. As a result of this issue, the Work Ethics course was redesigned. In order to ensure that the multiple layered scenarios worked efficiently and learners were not missing out on useful feedback, the default incorrect layers which would previously appear if a user did not make it to the end of the scenario for an incorrect answer were removed and replaced with custom feedback layers which informed the user right away why this was the wrong choice. Previously, it was the first response, or choice, by the user which was graded as, if a user chose the incorrect choice at beginning, their answer as a whole was always going to be incorrect. However, now it is the final choice which will be graded for the user. If the user manages to successfully make it to the end of the scenario and get the final decision correct, they will be awarded 20 points, otherwise they will receive 0 points. The new design of the course negated the need for a review option at the end of the course as users were receiving all the in-depth feedback and explanations necessary as soon as they decide which option to take. This method was then

implemented across all five scenarios.

Figure 17: Multiple layers of choices for scenario 1.

Incorrect Choice

Although you and John are friends, it is important to remember that John was violating company rules and was carrying out illegal acts using company equipment.

A company is responsible for all of its employees. So what John was doing could have had legal ramifications for the company itself. The company could have been sued and heavily fined for copyright infringement.

It is important to remember that you work for the company and it is here where your loyalties should lie. It is also important to remember that it is not your place or responsibility to confront John. Therefore, the correct action to take is to report such an issue to your manager as soon as possible.

Not being afraid to **Blow the Whistle** is an example of good work ethics.

Continue

Figure 18: Example of immediate feedback for an incorrect choice in scenario 1.

User Story 3

The third and final user story was the course which fused elements of Problem Based Learning and Scenario Based Learning into one: The Mathematics Shopkeeper Scenario. The general consensus among the user group which participated in this course for iteration one was that there needed to be more problems to solve, and a larger list of items in order to make the questions more diverse.

For iteration 2 of the Shopkeeper scenario problem solving course, a new menu was designed. Previously, the learner was tasked with calculating the balance in their cash register after dealing with customer transactions. Customers were purchasing, returning or exchanging different items in each scenario. The items could be found on a menu. The user could click the menu button to make the list appear, and click again to make it disappear. This menu consisted of carrots, apples, milk, bread, eggs, butter, soft drinks and bananas. For iteration 2, this menu was improved and contained an additional 8 items which were lettuce, cheese, ice cream, tomatoes, peppers, oranges, peanut butter and donuts.
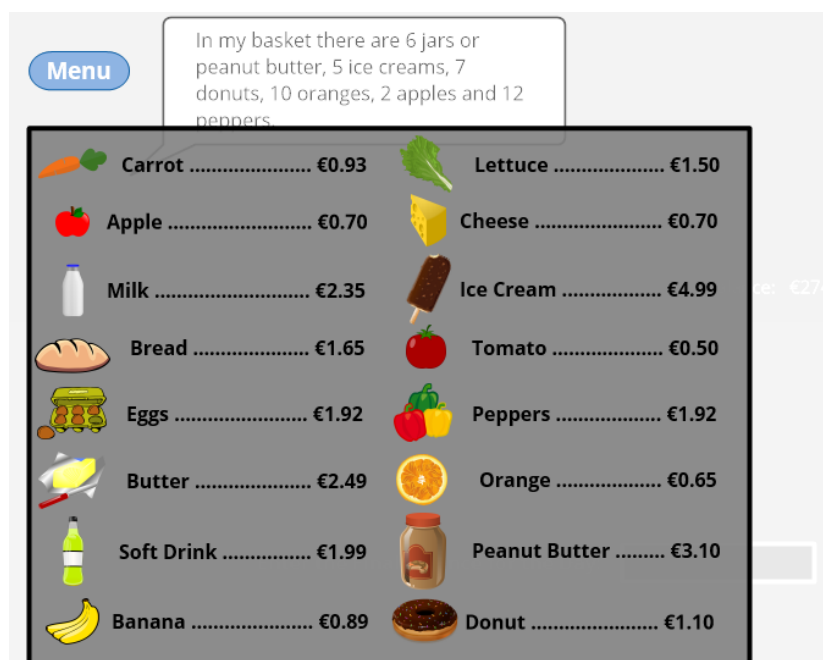
Figure 19: New menu of items for the Mathematics Shopkeeper Scenario course.

The number of customers in this course was also increased. Four new customer scenarios were implemented which brought the total number of problems to solve for this course up to twelve.

1.10 Customer 9

1.11 Customer 10

1.12 Customer 11

1.13 Customer 12

Figure 20: Four new scenarios created for the Mathematics Shopkeeper Scenario course.

Once improvements were made to the user stories, and additional functionality was added as required, the user stories were all once again published for the SCORM and xAPI e-learning standards. The courses were then hosted on the SCORM Cloud Learning Management System and assigned to the different learner groups.

SCORM and xAPI

 SCORM and xAPI are the two most popular and widely used e-learning standards for the authoring of e-learning content. As of today, SCORM is still the more popular choice compared to xAPI. However, there is a vast difference in the level of data that the SCORM standard can record about a learner's attempt of a course compared to that of the xAPI e-learning standard.

Records	SCORM	xAPI
Time Stamp		✓
When Course was Launched	✓	✓
Experienced a Slide		✓
Slide Name		✓
Default Scene and Slide Number	✓	
Content Slides		✓
Exam/Question Slides	✓	✓
Chosen Answer	✓	✓
Chosen Answer Correct/Incorrect	✓	✓
Score Received for Chosen Answer		✓
Course Completion	✓	✓
Course Completion Score (%)	✓	✓
Pass/Fail Course		✓
Realtime Log		✓
Linear Record of Events		✓
Unordered Record of Events	✓	

Figure 21: SCORM vs xAPI Features

The xAPI e-learning standard timestamped the different pieces of information that it could record for each e-learning course. Both the SCORM and xAPI standards also record when the user has launched the course.

The xAPI standard makes a record every time a user navigates to a new slide. The record indicates that the user has navigated to a specific slide and contains the name of this slide, which are formatted during the creation of the course in Articulate. This is helpful when the course contains a large quantity of scenes as slides as the administrator will know exactly which scenes and slides the learner has experienced by simply looking at the recorded data in the Learning Record Store (LRS).

2018-03-18T20:16:13.402	Michelle Byrne experienced 'Question'
2018-03-18T20:16:05.444	Michelle Byrne experienced 'WLAN'
2018-03-18T20:15:59.166	Michelle Byrne experienced 'WAN'
2018-03-18T20:15:44.211	Michelle Byrne experienced 'LAN'
2018-03-18T20:15:39.571	Michelle Byrne experienced 'Types of Networks'

Figure 22: xAPI Slide Experienced & Slide Name

xAPI records information for every slide in the course regardless of whether it is a content slide or an examination question slide. The learner's response to a question is also recorded along with an indication as to whether their answer was correct or incorrect, and how many points they received for their answer to the question.

| 2018-03-18T20:27:25.515 | Michelle Byrne correctly answered 'Match the type of Networking Address to the correct description.' with response 'statement_6UMAIB8n52H[.]cho...' with score 11 |
| 2018-03-18T20:23:44.127 | Michelle Byrne experienced 'Match the type of Networking Address to the correct description.' |

Figure 23: xAPI Records Information from Content Slides and Exam Slides.

Records regarding when, and whether the learner has completed a course are also recorded in the LRS. These records also contain information as to whether the learner has passed or failed the course and what score, as a percentage, they achieved for the course.

| 2018-03-18T21:14:59.357 | Michelle Byrne passed 'Workplace Ethics (xAPI)' with score 80% |

Figure 24: xAPI Course Completion, Pass/Fail, and User Score for Course.

The xAPI standard produces all of the record logs in real-time. As soon as an event occurs such as the accessing of a slide, or the answering of a question, a record will be made in the LRS. All recorded data for the xAPI e-learning standard in the LRS is also produced in an ordered, linear manner.

The SCORM e-learning standard does not record as much information about a learner's attempt at an e-learning course as the xAPI standard does. The SCORM standard does not make a record when a learner accesses a slide. This standard can only record information for slides which are questions. This means that the analysis that can be performed on SCORM courses is limited. For xAPI courses, you can use timestamps of content slides to determine, on average, which section took learners the longest to work through, however, with SCORM this is not possible. Furthermore, for the question slides, which it can record information about, it can only record the default scene and slide number which the question is on. This is fine for short e-learning courses where it would not be difficult to decipher which slide the question was referring to, however, for much larger courses, the e-learning administrator would need to have a breakdown of all the question slides and what they are about in order to know which question the user was on. More importantly, it is also important to remember that the e-learning administrator is not always the responsible for creating a course. The course could be created by a different individual, or organisation and is being used to train or teach the users who the e-learning administrator is responsible for. Therefore, the e-learning administrator may have no idea about scene and slide numbers as they did not create the course. This would mean that the administrator would be required to launch the course themselves and seek out the corresponding scene and slide number of a question, at least until they familiarise themselves well enough with that course.

Regarding the recording of answers, SCORM cloud can record a response, and whether that response was correct or incorrect. It cannot record the score the learner received for their answer.

SCORM also records the whether a course has been completed, and the percentage the learner achieved for the course. However, it does not record whether this percentage means that the user has passed or failed the exam. Different courses have different pass and fail percentages. For example, a user could achieve a score of 80%, however the pass percentage programmed into the course is 90%. Therefore, although the user received a high score of 80%, they have failed the course. Pass and fail percentages cannot be assumed, meaning the administrator, who is only responsible for assigning the learnings, would not know whether one of their learners has passed the course or failed it.

The SCORM e-learning standard does not record data in a consistent and linear manner. It was discovered that certain SCORM courses had their questions recorded in the order which they appeared in the course.

Finally, an unintentional discovery was made regarding how SCORM records information. It was found that, unlike xAPI, SCORM does not record information within the LRS in real time. One learner who had completed their course, sent a message to make it known. However, upon looking at the entries in the LRS, there was no record of this user's attempt. Sometime later, when the user went back on to their laptop, they found that they had not closed the course. Therefore, because the SCORM course was not closed, the information about the course was not recorded in the LRS. This is different to xAPI as with xAPI, data is recorded in the LRS as the events happen. Once the user closed the course, the entries appeared in the LRS. The timestamps on the events are rendered useless as they provide no insight as to how

a learner performed hours prior. This can cause issues as, as was the case with one learner in this iteration, if a user was to forget to close the course, no data would be recorded in the LRS about their attempt, as the SCORM standard would interpret it as the learner still partaking in the course.

It is not possible to analyse the timestamps of the SCORM data either, as the timestamps provide no insight as to how a user performed. As can be seen in the picture below, the SCORM timestamps only record the amount of time it took to store the recorded information in the LRS which is approximately 1 second. Therefore, no useful evaluation to determine most difficult questions and longest sections can be performed.

2018-03-19T16:19:20.367	Ronan Burke incorrectly answered 'Question Scene2_Slide7_FreeFormPickOne_0_0'
2018-03-19T16:19:20.366	Ronan Burke correctly answered 'Question Scene6_Slide7_FreeFormPickOne_0_0' with response 'c'
2018-03-19T16:19:20.365	Ronan Burke correctly answered 'Question Scene5_Slide5_FreeFormPickOne_0_0' with response 'g'
2018-03-19T16:19:20.364	Ronan Burke correctly answered 'Question Scene4_Slide6_FreeFormPickOne_0_0' with response 't'
2018-03-19T16:19:20.363	Ronan Burke correctly answered 'Question Scene3_Slide5_FreeFormPickOne_0_0' with response 'i'
2018-03-19T16:19:20.362	Ronan Burke completed 'Workplace Ethics (SCORM)' with score 80%
2018-03-19T16:19:19.734	Ronan Burke incorrectly answered 'Question Scene2_Slide7_FreeFormPickOne_0_0'
2018-03-19T16:19:19.733	Ronan Burke correctly answered 'Question Scene6_Slide7_FreeFormPickOne_0_0' with response 'c'
2018-03-19T16:19:19.732	Ronan Burke correctly answered 'Question Scene5_Slide5_FreeFormPickOne_0_0' with response 'g'
2018-03-19T16:19:19.730	Ronan Burke correctly answered 'Question Scene4_Slide6_FreeFormPickOne_0_0' with response 't'
2018-03-19T16:19:19.729	Ronan Burke correctly answered 'Question Scene3_Slide5_FreeFormPickOne_0_0' with response 'i'
2018-03-19T16:19:19.728	Ronan Burke completed 'Workplace Ethics (SCORM)' with score 80%
2018-03-19T16:06:04.204	Ronan Burke attempted 'Workplace Ethics (SCORM)'

Figure 25: All SCORM recordings for the Work Ethics Course.

Analysis

While there is not much analysis that can be performed on the SCORM recordings other than what is presented at face value, the xAPI courses can be analysed through the utilisation of

their timestamps.

By analysing the Networking course timestamp statistics for the xAPI users, the average course length, longest course section, and the exam questions which took longest where able to be determined.

The average time taken to complete the Networking course was found to be approximately 27 minutes. This was found by comparing the xAPI users' starting and ending timestamps from the LRS.

Networking	Start Time	Finish Time	Time to Complete	Course Version
User 1	20:00	20:29	29	xAPI
User 2	19:33	19:58	25	xAPI

Avg Course Length:	27 Minutes

Figure 26: Networking Avg. Course Completion Time

The section of this course which took the longest to complete was found through examining the length of time it took a user to progress through each section. This was relatively easy to do with the way xAPI records slide names, meaning it was easy to determine when the leaner reached the next section. It was revealed that the section which took users the longest, apart from the quiz at the end, was the 'Types of Networks' section, and the section which learners found easiest and spent the least amount of time on was the 'Hardware' section.

Networking	Networks	Hardware	Types of Networks	Addressing	Quiz
User 1	3	1	8	6	11
User 2	2	1	7	5	10

Figure 27: Networking Course Section Times (Minutes)

Finally, the timestamps were analysed to determine which questions users spent the longest on. Although there were two different branches to take in the Networking exam, both learners ended up following the same one. This made it easier to determine which question

took learner's the longest time to answer. This was determined by observing the time from when a learner experienced a slide, to the time they submitted an answer for the question on that slide. It was found that the questions which took the longest for users to answer where the two questions which required learners to match a description to a name. The question which asked learners to match the type of Networking address to the correct description took an average of 5 minutes for the users to complete was answered correctly by all xAPI users. Although the SCORM versions of the course cannot be analysed regarding time, it is important to note that 50% of the SCORM users got this question wrong. The second longest question was the matchup question which asked users to match the hardware to its description. This question took an average of 3 minutes to answer and was answered incorrectly by all xAPI users. Similarly, all SCORM learners got this question incorrect as well. This is a useful analysis as it means that the 'Hardware' section of the course is one that may need to be looked at and improved to ensure that learners are retaining the necessary information from that section.

The second user story regarding the Scenario Based Learning Work Ethics course was also analysed. First of all, the times that each xAPI user took to complete the course in its entirety were used to determine an approximate course length. The estimated course length was found to be approximately 11 minutes in duration.

Work Ethics	Start Time	Finish Time	Time to Complete	Course Version
User 1	19:12	19:25	13	xAPI
User 2	21:10	21:18	8	xAPI

Avg Course Length:	11 minutes

Figure 28: Work Ethics Avg. Course Completion Time (Minutes)

Next, the times it took for the completion of each scenario were analysed in order to determine which scenario took users the longest and which scenario took users the least amount of time to complete.

Work Ethics	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
User 1	3	3	2	1	4
User 2	2	2	1	1	2

Figure 29: Work Ethics Scenario Completion Times (Minutes)

From extracting the necessary data, it was uncovered that the scenario which took the longest on average was the final scenario, Scenario 5, regarding the disgruntled customer. The scenario which took users the least amount of time to complete was Scenario 4 which was to do with stealing from your organisation.

Out of all the course attempts, both SCORM and xAPI, Scenario 2 which emphasised a need to honour a confidentiality agreement that you have made with your organisation, was answered incorrectly by 50% of learners.

The final user story, the Mathematics -Shopkeeper Scenario course was also analysed. The completion time for this course was 51 minutes. This was the longest course by far. All users got the final question incorrect, and the problem which took learners the longest to solve was question 3, which took 7 minutes to solve. The 'Customer 3' scenario was the only scenario which required learners to subtract and add values in order to determine the new cash register balance. 'Customer 7' was a problem which required the user to exchange an item, meaning the balance remained the same. Surprisingly, this was not the problem which tool learners the shortest time to solve. It was in fact 'Customer 8' which took learners approximately 1 minute to solve. This scenario contained a customer purchasing 3 different types of items.

This type of useful analysis is not possible with SCORM e-learning content due to the numerous restrictions the SCORM e-learning has regarding what it can record. The xAPI standard was found to be much more advanced in terms of what it has the ability to record about a learner's attempt at an e-learning course.

Going Forward

I still feel that there is more analysis which can be drawn from both the SCORM and xAPI standards going into iteration 3. I believe that if I had access to a much larger user group, analysis would become easier and results would be much clearer.

I was not pleased with the course durations which were determined for this iteration. I feel that the Networking course in particular needs to be extended for the final iteration. I would hope to put in some additional content and more exam questions into this user story.

The Work Ethics scenario for this iteration required an entire redesign in order to make the multiple-layered scenarios possible. As this required a large amount of time to perform successfully, I only managed to design 1 new scenario. I would hope to create at least 1 more in-depth scenario for the iteration 3 Work Ethics course, if not 2 extra scenarios.

The PBL and SBL fusion course, Mathematics – Shopkeeper Scenario, is the longest course by far and already contains 12 challenging problems. The aim with this course is to bring the total problems up to 15 and redesign a handful so it is not comprised of problems in which learners are constantly forced to only add values.

Overall, the feedback which was generated from the user group surveys were very positive. All learners felt that the courses which they participated in had improved and their suggestions had been taken on board and acted upon. Many shared the same opinion as myself regarding the length of the Network course, so this is an issue I will resolve for the final iteration.

Section 7: Iteration 3

Iteration 3

Through iteration 2, it was uncovered that the xAPI e-learning standard is far superior to the SCORM e-learning standard regarding what each of the standards can record about a user's e-learning course attempt.

Records	SCORM	xAPI
Time Stamp		✓
When Course was Launched	✓	✓
Experienced a Slide		✓
Slide Name		✓
Default Scene and Slide Number	✓	
Content Slides		✓
Exam/Question Slides	✓	✓
Chosen Answer	✓	✓
Chosen Answer Correct/Incorrect	✓	✓
Score Received for Chosen Answer		✓
Course Completion	✓	✓
Course Completion Score (%)	✓	✓
Pass/Fail Course		✓
Realtime Log		✓
Linear Record of Events		✓
Unordered Record of Events	✓	

Figure 30: SCORM vs xAPI

While uncovering what each e-learning standard can record was a great achievement, it is important to show, using the information from the users' attempts of user stories 1, 2 and 3, how the data recorded by the standards can be used and what conclusions can be drawn thanks to the level of data recorded by one e-learning standard in particular.
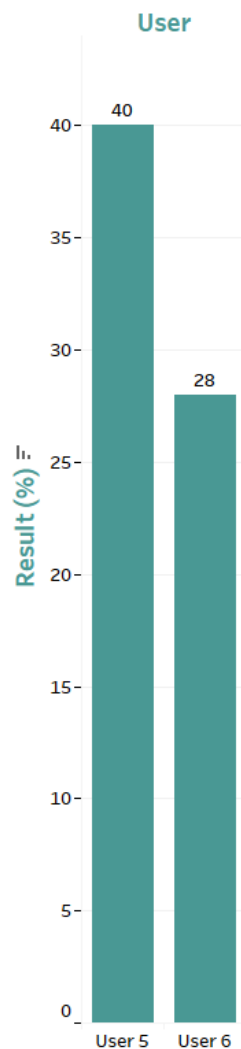
Through this third, and final, iteration, the data which was recorded by each e-learning standard from the 3 different user stories will be visualised and analysed, using Tableau, to highlight how interpreting data about users' e-learning course attempts can be extremely beneficial in order to create the most effective, and efficient content for e-learning courses.

PBL Networking Course – SCORM

SCORM is limited regarding the level of data it can record from e-learning course attempts.

Therefore, the level of analysis and the number of visualisations which can be generated from

the SCORM e-learning standard are also limited.

Figure 31: Bar Chart of Networking (SCORM) Users vs. Results

One visualisation which can be created is to determine how each SCORM user performed

in the course, and what result they achieved. SCORM's inability to produce time stamps for all the events which it records severely affects how e-learning administrators or e-learning authors can interpret the data about their users. While it is possible to analyse the result each user received, it is not possible to uncover why they achieved such a result. Furthermore, this visualisation, due to SCORM's recording limitations, does not indicate whether the scores that these two learners received mean that they have passed or failed the course.

Text Table of Networking (SCORM) Users vs. Answers

User	Question 1	Question 2	Question 3	Question 4	Question 5	Question 6	Question 7	Question 8
User 5	Correct	Incorrect	Incorrect	Incorrect	Correct	Incorrect	Incorrect	Correct
User 6	Correct	Incorrect	Incorrect	Incorrect	Incorrect	Incorrect	Incorrect	Correct

Figure 32: Text Table of Networking (SCORM) Users vs. Answers

One other visualisation which can be created is a text table indicating which answers each of the two users provided a correct response to. SCORM does not record the names given to slides, it only provides a scene and slide number. This would make it very difficult to analyse users' answers in courses which are extremely large and contain many different scenes. However, as the Networking Problem Based Learning course only contains 6 scenes, all of which were created by myself, I was able to determine which questions the users got correct and incorrect. In the previous iteration, I implemented a branched exam for the Networking course which would be triggered depending on the learners' response to the first question. As both learners answered the first question correctly, they both followed the same exam branch. Questions 2, 3, 4, 6 and 7 were answered incorrectly by both users. By looking into what section each of these questions were based on, it can be determined that question 2 was based on the Hardware section, with question 3, 4 and 6 based on content from the Addressing section, and questions 4 and 7 coming from the Types of Networks section. This

indicates that both users appear to have struggled with these 3 sections. However, it is important to note that, with SCORM, there is no indication as to why they struggled with these sections, and that, due to the small nature of this course, the analysis which can be drawn from the correct and incorrect answers is a rare occurrence as, if the course was much larger, or the exam questions were not just grouped into a single section at the end of the course, it would be much more difficult to determine which questions are from which section.

These two visualisations are the extent of the analysis which can performed on the SCORM version of the Networking Problem Based Learning course.

PBL Networking Course – xAPI

The xAPI e-learning standard records a lot more information about learners' e-learning course attempts. This means that xAPI garners the ability for a lot more analysis of the recorded data compared to that of the SCORM e-learning standard.
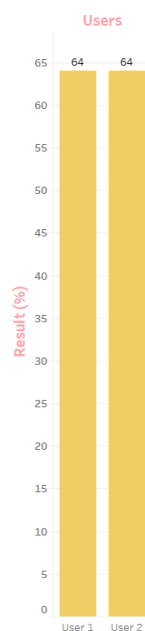

Figure 33: Bar Chart of Networking (xAPI) Users vs. Results

The bar chart which pits the user group against the results they achieved in the course is not exclusive to the xAPI standard. As seen previously, such a visualisation can also be constructed using the SCORM e-learning standard. This bar chart informs of the result which each user achieved for the xAPI version of the Networking Problem Based Learning course. Surprisingly, both users who partook in this course, user 1 and user 2, achieved the same final score of 64%. While 64% is a relatively high score, it is never wise to just assume whether the result is a pass or a fail. Different e-learning authors use different passing scores for their content meaning, while 64% may be mean a user has passed one course, a different course may have a pass percentage of 70% which would mean that the user has failed this course. The xAPI standard, unlike SCORM, records a learner's result, i.e 64%, while also indicating whether this percentage means the learner has passed or failed the course. Therefore, the pass/fail variable can be used as a coloured overlay on the current visualisation in order to determine whether or not this result is a pass.
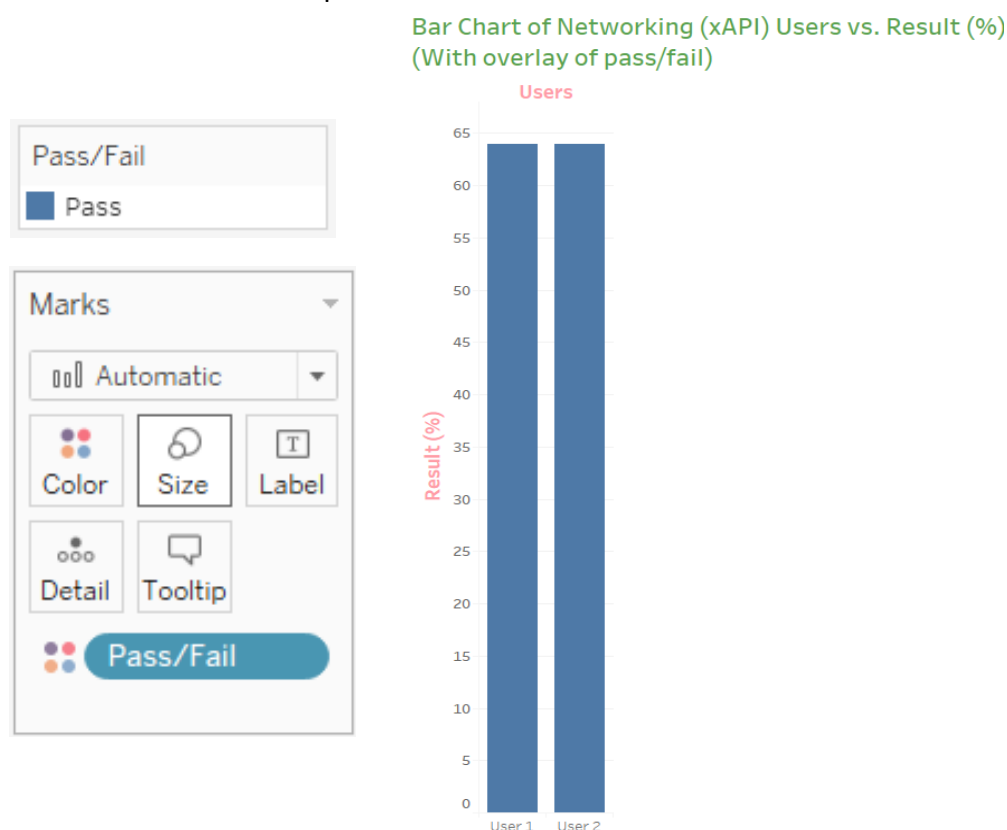

Figure 34: Bar Chart of Networking (xAPI) Users vs. Results with Overlay of Pass/Fail.

From the new and improved bar chart, it is clear that both users have successfully passed the course.

One major advantage which xAPI has over SCORM is in its ability to record time stamps for every event in its log. This means that meaningful data analysis can be carried out using the users' performance and time. By examining the time stamps of when the user launched and then finished a course, the length of time it took each user to complete the course can be determined.

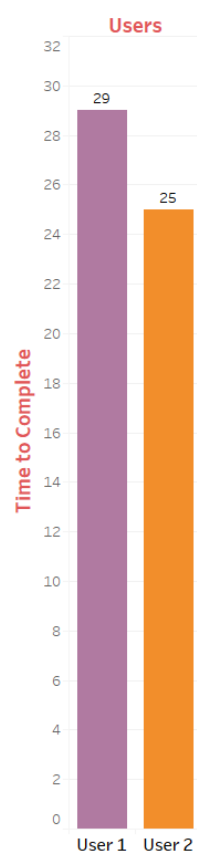Bar Chart of Networking (xAPI) Users vs. Time to Complete

Figure 35: Bar Chart of Networking (xAPI) Users vs. Time to Complete Course

As can be seen in this bar chart representing each user and the time, in minutes, it took them to complete the course, it took User 1 a total of 29 minutes to complete the course, while taking User 2 a total of 25 minutes. However, with the xAPI timestamp, we can also delve deeper into the users' performance and determine how much time they spent on each section of the Networking course.

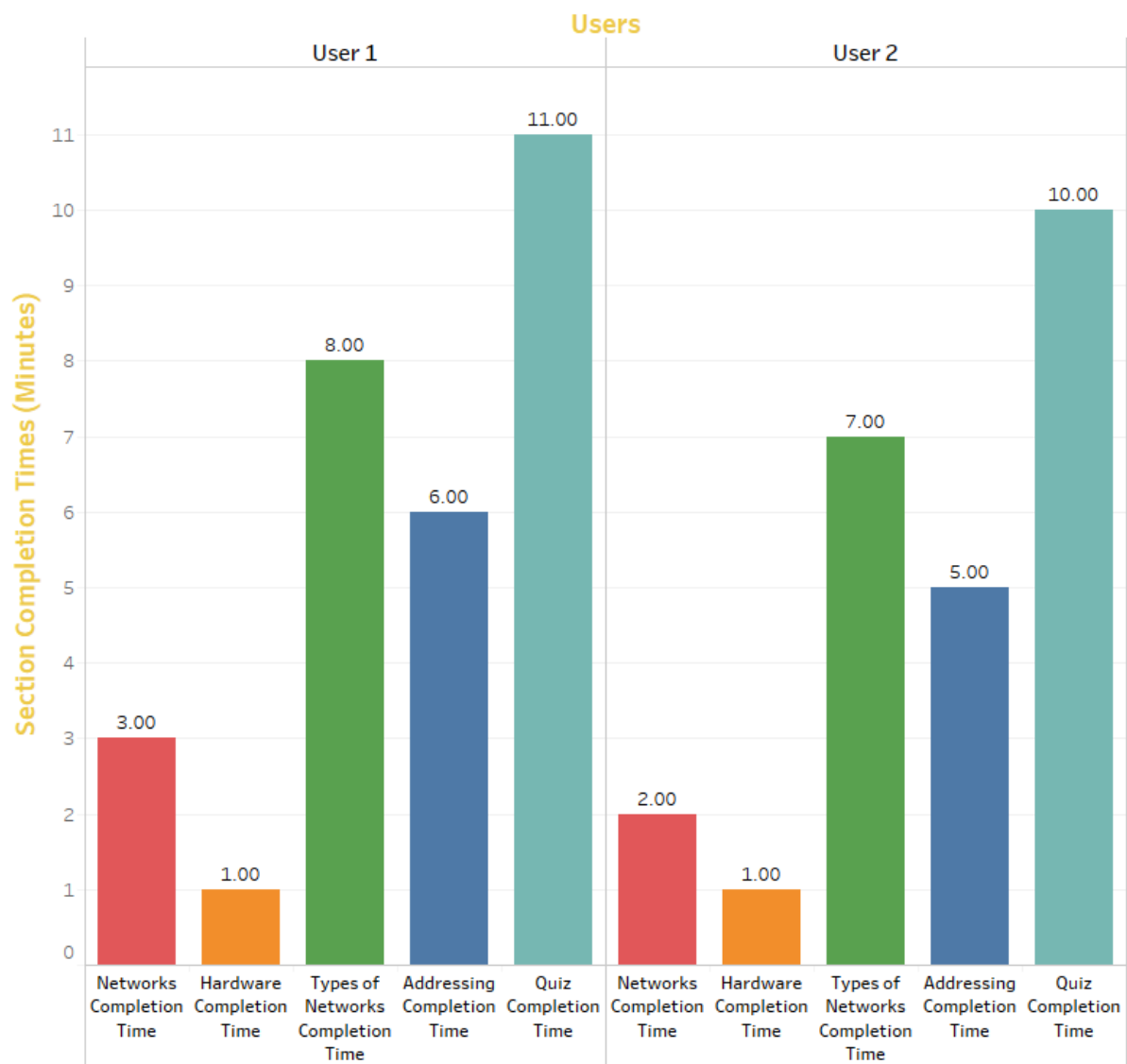Side-by-side Bars of Networking (xAPI) Users vs. Section Completion Times

Figure 36: Side-by-side Bars representing Users vs. Section Completion Times.

While the total completion times may be different for User 1 and User 2, their times are identical regarding which section they spent the longest on, which section they spent the shortest amount of time on, and everything in between. For User 1, the section which took them the longest to work through was the quiz, followed by Types of Networks, Addressing, Networks and Hardware respectively. The exact same is true for User 2. From this information, it can be determined that the Types of Networks content section takes learners the longest amount of time to work through, with Hardware being the quickest section for users to work through at 1 minute.

Next, the score each user received for each question in the exam section of the course. This, to an extent, is also achievable, as seen previously, with the SCORM e-learning standard, however, the SCORM standard only states whether the answer was correct or incorrect while the xAPI standard does the very same but goes further to also include the score the user received for the answer.
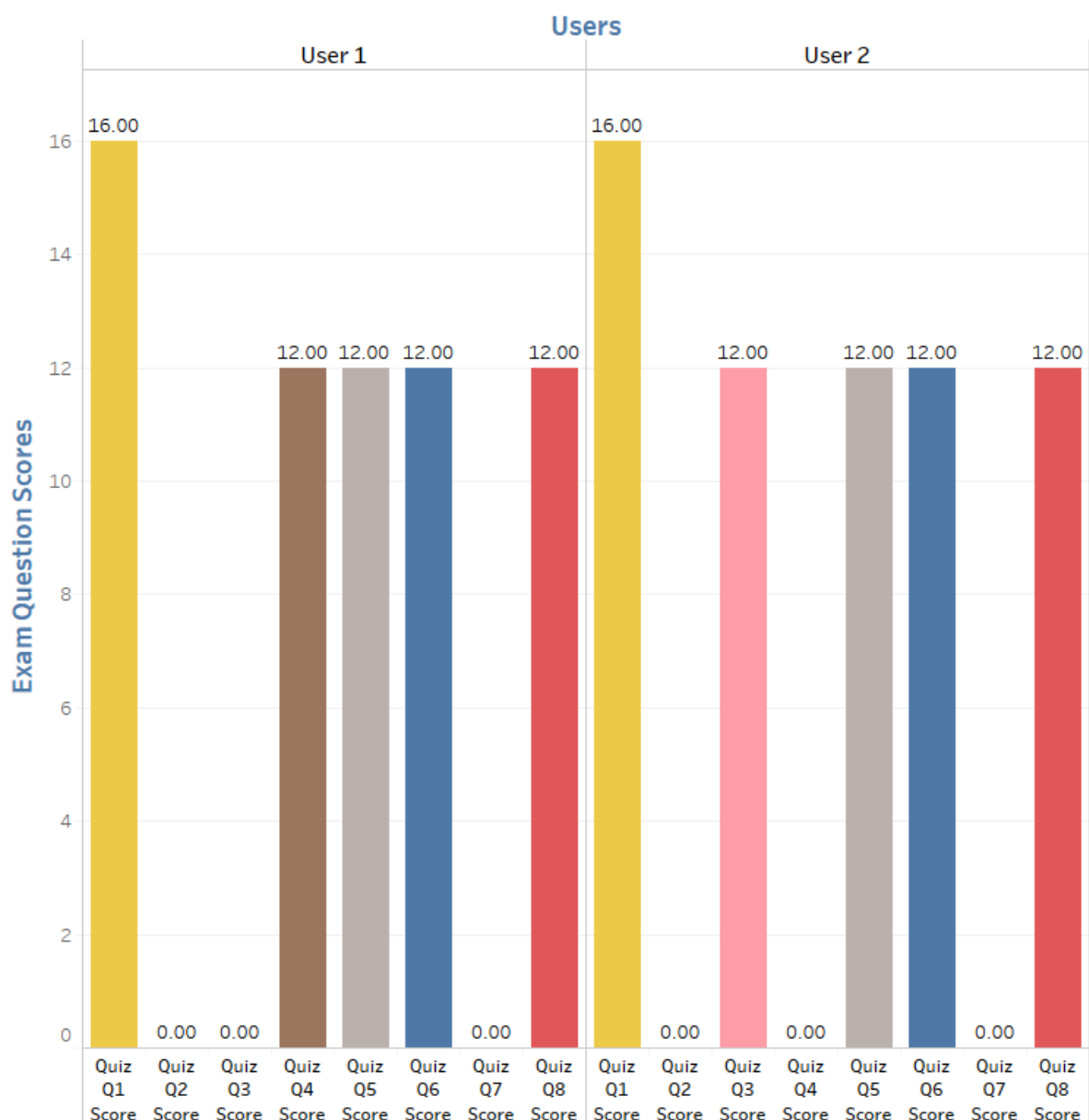

Figure 37: Side-by-side Bars Representing Users vs. Scores per Exam Question

From this piece of data, we can see that User 1 answered questions 2, 3 and 7 incorrectly as they received 0 score for them. We ca also see that User 2 answered questions 2, 4 and 7
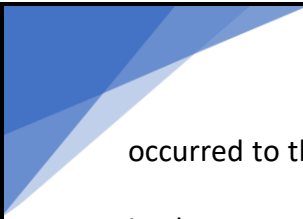
incorrectly. By observing what sections each question was based on, we can see that User 1 answered questions that were based on Hardware, Addressing and Networks incorrectly, with User 2 answer questions based on Hardware, Types of Networks and Networks.

Question	Section	User 1	User 2
1	Networks	Correct	Correct
2	Hardware	Incorrect	Incorrect
3	Addressing	Incorrect	Correct
4	Types of Networks	Correct	Incorrect
5	Addressing	Correct	Correct
6	Types of Networks	Correct	Correct
7	Networks	Incorrect	Incorrect
8	Hardware	Correct	Correct

Figure 38: Table Indicating Exam Question Sections & Correct/Incorrect Answers

By using this information, along with the section completion times visualisation, it can be seen that the Hardware section, of which question 2 was based on and was incorrectly answered by both learners, was the section which both learners spent the least amount of time on. Only 1 minute of both users' times was spent on the Hardware section. This indicates one of two possibilities, either the learners did not spend as much time as they should have completing this section and rushed through it, or that the content was perhaps too intense and not simplified enough for beginners, who are this course's audience, and they lost interest in the section meaning the format of this section did not facilitate learning for the two users. However, it is also important to note that the exam contained a second question based on the Hardware section, which both learners answered correctly, which could be an indication that the section perhaps was not structured well enough to ensure the learner was retaining all relevant information. Another question which both users answered incorrectly was question 7 which was based on the Networks section. This section took User 1 and User 2 a total of 3 and 2 minutes to complete respectively. This could mean that a similar issue has

occurred to the one from question 2, as both users correctly answered the second question in the exam based on the Network section. User 1 also incorrectly answered question 3 regarding Addressing. As this section was the second longest content section of this user's attempt, it is likely that they user perhaps had forgotten the information necessary to answer this question by the time the exam had occurred. This could be another example of the structure of the content in this section not fully facilitating the learning of the user. User 2 incorrectly answered a question based on the Types of Networks content section. This section took this user the longest to complete which could be an indication that perhaps the content in this section was too heavy and perhaps contained some difficult elements.

This type of analysis is impossible with the SCORM e-learning standard. Only with xAPI is it possible to perform such in-depth analysis regarding your learners. The objective of every e-learning author is to make the most efficient and effective e-learning content possible. Similar for e-learning administrators, they wish for their learners to be using the most effective, efficient, and relevant e-learning content possible. The analysis which is possible with xAPI coupled with user experience surveys will allow the e-learning authors to achieve their goal of creating the best content, while also allowing e-learning authors to ensure their learners are finding the material valuable and effective. An example of using user experience surveys effectively can be found by looking back to the iteration 1 and iteration 2. In these iterations, when users attempted the course, they completed surveys which indicated what was and was not effective about the course such as the networking navigation being too complicated to use. Questions such as what are the most difficult and easiest sections can be found here. Then it is possible, with xAPI courses, to analyse the data about the learner's attempt and relate it to the feedback which they provided in order to evaluate their performance, and

make any necessary changes to the course to make it more effective for all learners. However, it is important to remember that this cannot be done with the SCORM e-learning standard as there is no way to determine which sections learners spent the most and least time, and then compare that with their overall grade for the course.

User Story 2

User Story 2 was the Scenario Based Learning Work Ethics course. The data of all learners' course attempts, SCORM and xAPI, will be analysed through visualisations. Similar to the User Story 1 analysis, there will be a lot more analysis possible from the xAPI version of the Work Ethics course, as opposed to the SCORM version of the Work Ethics course.
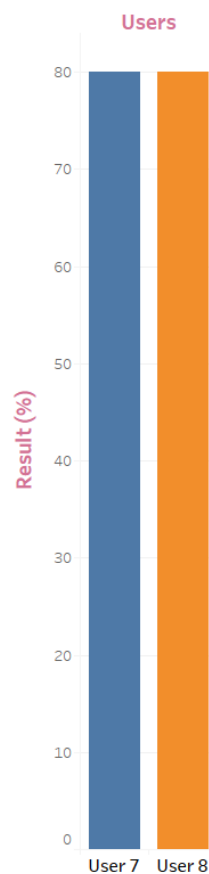
SBL Work Ethics Course – SCORM

Figure 39: Bar Chart representing Work Ethics (SCORM) Users vs. Results

The first piece of analysis which can be carried out on the SCORM version of the Work Ethics course is on the results each user received. User 7 and User 8 took part in this version

of the course, and they both achieved a score of 80%.

The next objective is to determine whether or not learners provided the correct or incorrect response to each scenario.

Text Table of Work Ethics (SCORM) Users vs. Scenario Results

Users	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
User 7	Incorrect	Correct	Correct	Correct	Correct
User 8	Incorrect	Correct	Correct	Correct	Correct

Figure 40: Text Table of Work Ethics SCORM Users vs. Scenario Results.

This information allows us to see that both learners only answered 1 scenario incorrectly, which was Scenario 1. Scenario 1 was based on doing what is best for your organisation and not being afraid to 'blow the whistle' when necessary. Both users providing incorrect responses to this scenario could be an indication that perhaps the scenario is not clear enough.
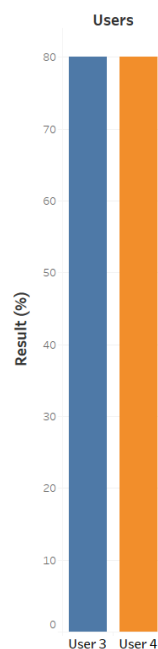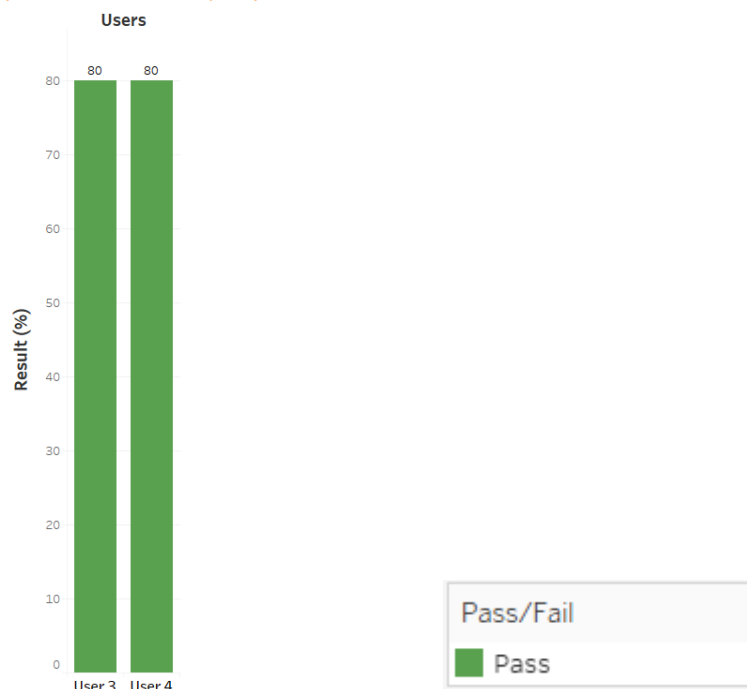
SBL Work Ethics Course – xAPI

Figure 41: Bar Chart Representing Work Ethics (xAPI) Users and their Results

The first visualisation indicates how the two users, User 3 and User 4, performed in the course by presenting their overall grade. This piece of data tells that both users have achieved a score of 80% in this course. The xAPI standard also includes whether the user has passed or failed the course. This means that it is now possible use the Pass/Fail variable as an overlay on the users' results to determine whether or not they have passed the course.

Figure 42: Bar Chart of Results with Overlay of Pass/Fail

As can be seen with the Pass/Fail overlay, both User 3 and User 4 have passed the Work Ethics course.

The next piece of analysis to be carried out is to determine the length of time each learner took to complete the course. As can be seen in Figure 13 below, User 3 took a total time of 13 minutes to work through all scenarios and complete the course, while User 4 finished the course in a quicker manner with a total time of completion of 8 minutes for the Work Ethics course.

Figure 43: Bar Chart of Work Ethics Users vs. Time to Complete

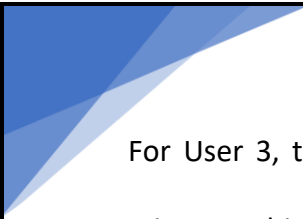It is important to see the time breakdown of the times each user spent on each of the five

scenarios in the Work Ethics xAPI course.

Side-by-Side Bars of Work Ethics (xAPI) Users vs. Time to Complete Scenarios
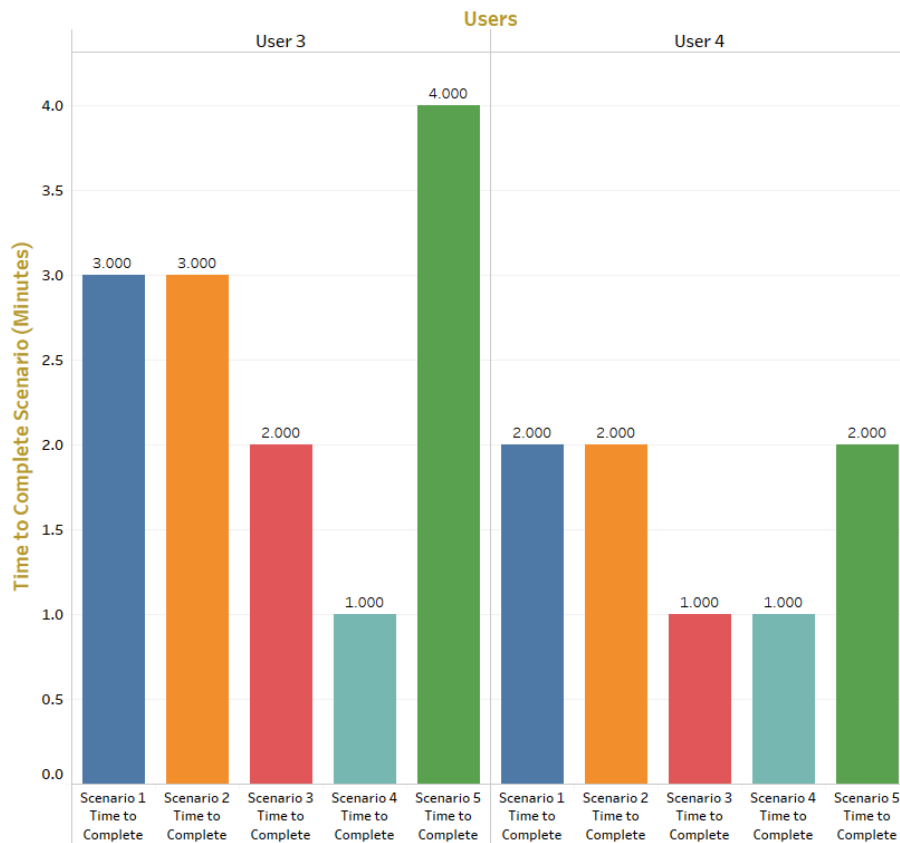
*Figure 44: Side-by-side Bars of the Time Taken to Complete Each Scenario*

For User 3, the Scenario which took the longest to work through was Scenario 5 with 4 minutes which was based on the importance of staying professional at all in times in your employment. This was followed by Scenario 1 which was based on not being afraid to 'blow the whistle' when necessary, and Scenario 2 which was based on honouring your confidentiality agreement, both of which took 3 minutes. Next was Scenario 3 which was to do with taking responsibility and active in a timely manner to rectify a mistake. This scenario took User 3 2 minutes to complete. Finally, the scenario which this user completed the fastest was Scenario 4 which was to do with not stealing from your employment. This scenario took a total of 1 minute.

For User 4, Scenario 1, Scenario 2 and Scenario 5 were all tied at 2 minutes as this user's quickest scenarios. These were followed by Scenario 3 and Scenario 4 which were tied for the shortest scenarios with a total time of 1 minute.

Upon visualising which questions the xAPI learners got correct and incorrect, which can be seen in Figure 16 below, it was evident that both User 3 and User 4 incorrectly responded to Scenario 1. An important note to make is that similarly, in the SCORM version of this course, User 7 and User 8 also responded correctly to every scenario except for Scenario 1. The fact that all 4 users who attempted this course, regardless of the version, answered Scenario 1 incorrectly could be an indication that perhaps this Scenario was not clear enough or caused some confusion among learners. Regarding User 3 and User 4, Scenario 1 was one of the longest scenarios for both users. Therefore, it is unlikely that they had rushed through the scenario without paying attention to the different actions to take. This could be an indication that Scenario 1 needs to be redesigned so that it is easier to interpret and understand.

Side-by-Side Bars of Work Ethics (xAPI) Users vs. Scenario Scores
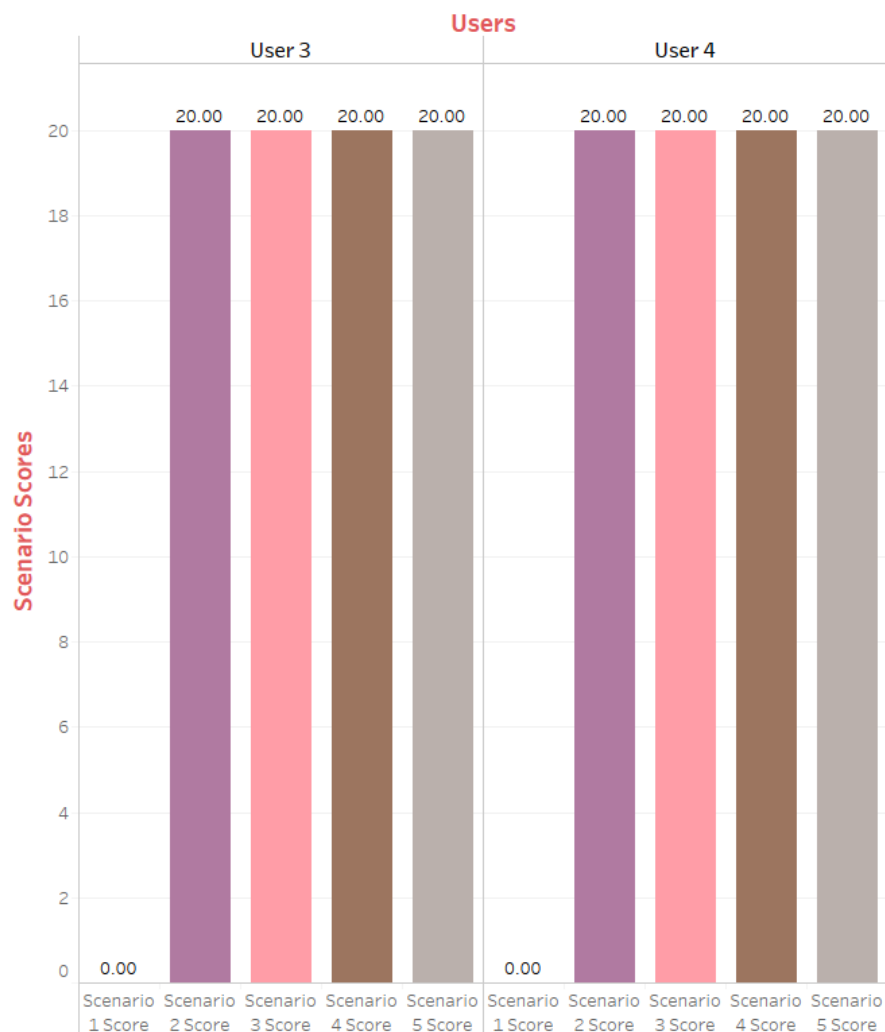
Figure 45: Side-by-side Bars of Work Ethics Users vs. Scenario Scores

Once again, with User Story 2 this time, the major difference between what the e-learning standards SCORM and xAPI can record, and how much more analysis can be performed with xAPI is evident.

User Story 3 was the Shopkeeper Scenario – Mathematics course which was a combination of Scenario Based Learning and Problem Based Learning. It is also the final user story of this project.

PBL/SBL Shopkeeper Scenario Course – SCORM

The first piece of data which can be analysed from the SCORM version of the Shopkeeper Scenario course is the result which the sole user received for their course attempt.

Figure 46: Bar Chart Representing the Shopkeeper (SCORM) User vs. Their Course Result

The user who participated in this course, User 6, achieved a percentage of 64 for their attempt of this course.

One other analysis that can be carried out on the SCORM version of the Shopkeeper course is in relation to what scenario problems the learner answered correctly or incorrectly.

Text Table of Shopkeeper Course (SCORM) User vs. Answers.

Users	Customer 1	Customer 2	Customer 3	Customer 4	Customer 5	Customer 6	Customer 7	Customer 8	Customer 9	Customer 10	Customer 11	Customer 12
User 6	Correct	Incorrect	Correct	Incorrect	Correct	Correct	Correct	Correct	Correct	Incorrect	Correct	Incorrect

Figure 47: Text Table Representing the User's Correct & Incorrect Answers

These results illustrate that User 6 incorrectly answered questions 2, 4, 10 and 12. As all of the problems to solve in this course are mathematics based questions, the reasons as to why the user incorrectly answered these questions could be due to user error, or due to the fact that perhaps they did not understand the question, or even perhaps they were too complicated to solve.
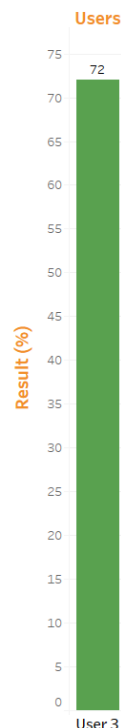
PBL/SBL Shopkeeper Scenario Course – xAPI

Figure 48: Bar Chart of Shopkeeper Scenario Course (xAPI) User vs. Result

The first visualisation for the Shopkeeper Scenario Course which can be analysed is in relation to the User 3's result for the course. This data tells that this user received a result of 72% for their attempt of this course. The Pass/Fail data variable can then be used as an overlay to determine whether a final result of 72% means that the user has passed or failed the course.
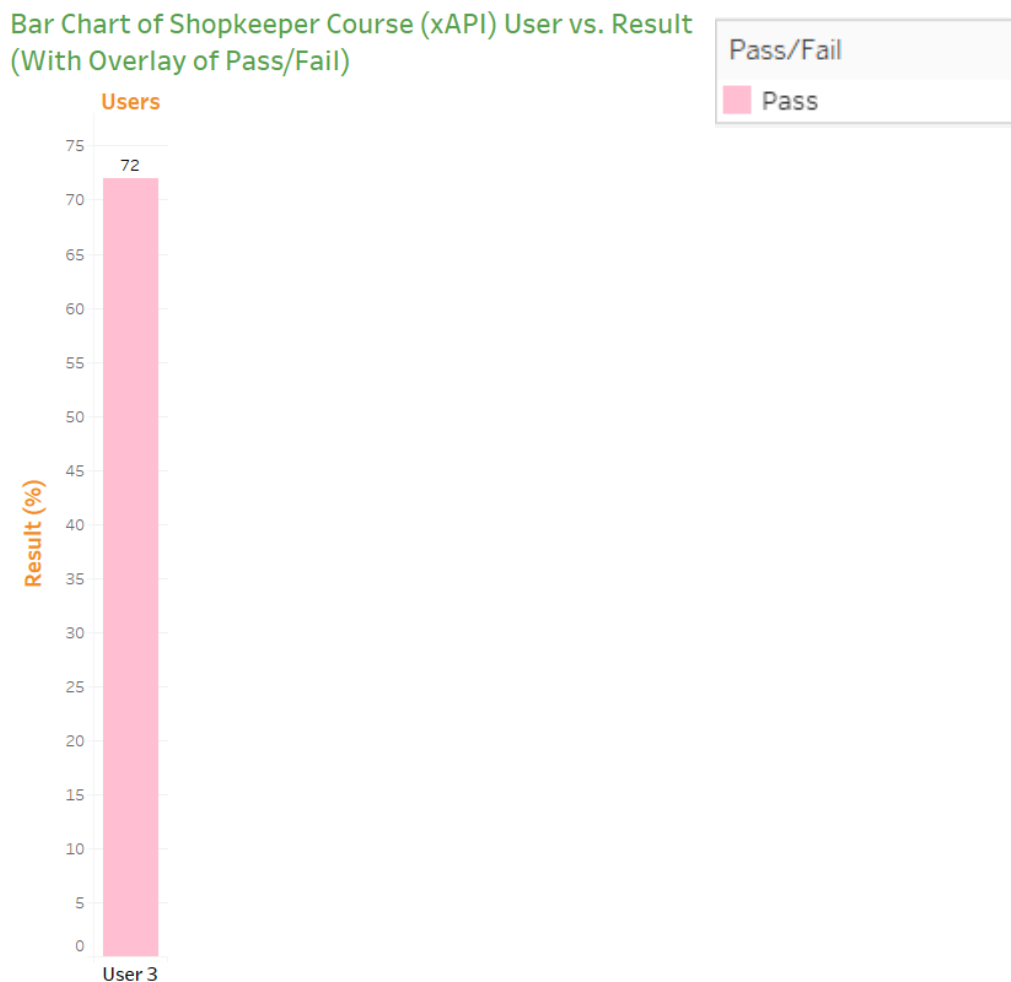
Figure 49: Bar Chart of Shopkeeper Course (xAPI) User vs. Result with Overlay of Pass/Fail

Using the Pass/Fail variable as an overlay it is clear to see, in Figure 20, that the user, User 3, has successfully passed the Shopkeeper Scenario course.

The next piece of analysis to be carried out is to examine the length of time that it took the learner to fully complete the xAPI Shopkeeper Scenario Course. As can be seen below in Figure 21, the learner took a total of 51 minutes to complete the course, making User Story 3 longer than User Story 1 and User Story 2.

Bar Chart of Shopkeeper Course (xAPI) User vs. Time to Complete

Figure 50: Bar Chart of Shopkeeper Course (xAPI) User vs. Time to Complete

Now that the total time to complete the course for User 3 has been uncovered, it is time to delve deeper and find the length of time the user spent on each customer scenario problem.

Figure 51: Side-by-side Bars of Shopkeeper Course (xAPI) vs. Time per Question

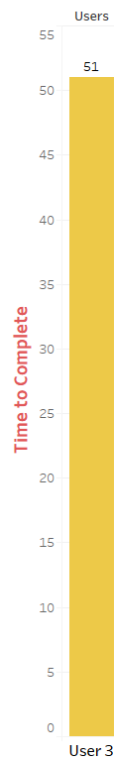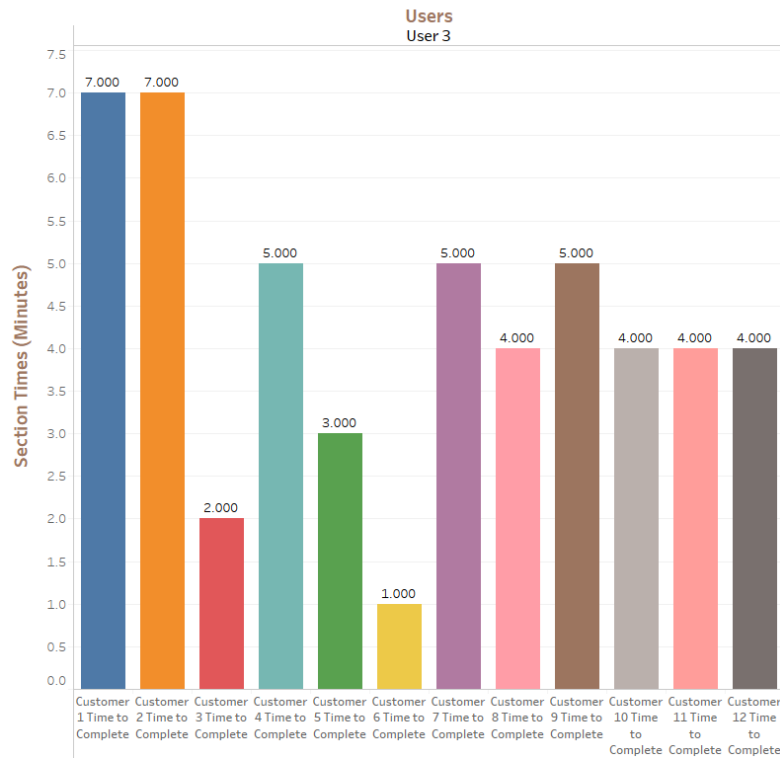The times which User 3 spent on each of the different customer scenarios are as follows:

Customer Scenario Problem	Time (Minutes)
Customer 1	7
Customer 2	7
Customer 3	2
Customer 4	5
Customer 5	3
Customer 6	1
Customer 7	5
Customer 8	4
Customer 9	5
Customer 10	4
Customer 11	4
Customer 12	4

Figure 52: Table of Times Spent on Each Problem by User 3

This data illustrates that customer scenarios 1 and 2 took the user the longest time, requiring 7 minutes each to complete. This was followed by Customers 4, 7 and 9 which took 5 minutes each to complete. Customers 8, 10, 11 and 12 were tied at a total of 4 minutes, with Customers 5 and 3 following with a time of 3 minutes and 2 minutes respectively. Finally, the Customer 6 scenario problem was completed in the quickest amount of time, taking only 1 minute for the user to work through it.

Finally, knowing that the user has passed the course, and that it took them 51 minutes to complete, and that the time spent on each question is known, it is time to evaluate their performance in the course by visualising the data relating to the scores they received for each scenario. As can be seen in Figure 23, the learner answered all questions correctly except for 3 of them. The 3 customer scenario problems which User 3 answered incorrectly were Customer 2, Customer 10 and Customer 12. Important information which can be extracted is how both the SCORM and xAPI user responded incorrectly to Customers 2, 10 and 12. This could be an indication that these questions were worded in a trickier manner than others

or perhaps these scenarios were more difficult than others. Due to the length of time which User 3 allocated to each scenario, whether correctly or incorrectly answered, indicates that this was not a case of this learner rushing through the course and it is more likely a case of the question being unclear or else the form of calculations required for these questions are weak spots for the learner.

Side-by-side Bars of Shopkeeper Course (xAPI) User vs. Question Scores
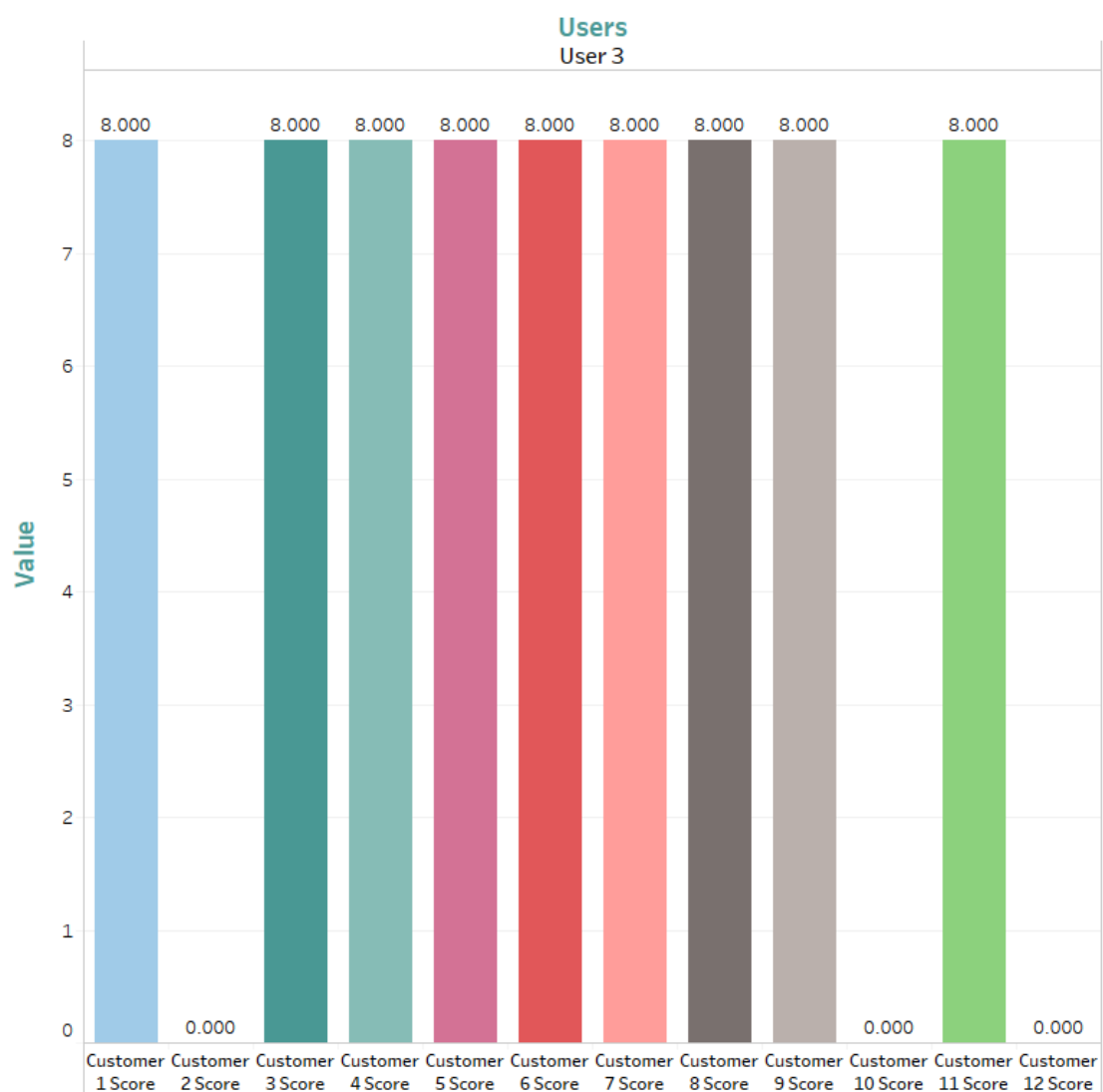
Figure 53: Side-by-side Bars of Shopkeeper Course (xAPI) User vs. Question Scores

For the third time, with User Story 3, the difference between what each standard can record is clear.

Conclusion and Recommendations

The main objective of this entire project, from the idea was developed in September 2018, through all the iterations to now, was to determine which e-learning standard was the superior choice for the creation of e-learning content. I believe that this very question has been answered through this project.

The SCORM e-learning standard is the most popular standard for authors to use when they are creating e-learning content. However, it is clear that, while SCORM is the most popular choice of e-learning standard, it is not the best. The xAPI e-learning standard is far superior regarding what it can record about learners compared to SCORM. SCORM is limited in what it can record. This standard can only record entries related to exam question slides, whether the answer was correct or incorrect, and the final result which a learner received for their course attempt.

The xAPI standard however, can record far more than the SCORM e-learning standard. One of xAPI's major advantage over SCORM is in its ability to record timestamps for all of its record entries. This allows in depth analysis to be carried out on learners' performances. xAPI allows administrators to learn more about their user groups. By analysing the length of time a user spends on the course in total, or on specific sections of a course, admins can interpret which sections were the longest and which sections of the course the user found the most difficult. Then, by examining what questions the user answered correctly and incorrectly in the exam sections of courses, admins can begin to uncover the strengths and weaknesses of their learners by mapping incorrect and correct answers to the sections

of the e-learning on which these questions were based, while also factoring in the length of time spent on the respective section. The xAPI records all entries for content and questions slides, unlike SCORM which can only record questions slides. This is how it is possible to analyse how long learners spend on different course sections or how long they take to complete different exam questions.

Another advantage xAPI has over SCORM is that it records the names of scenes and slides which were encoded during course creation. This makes it easy to understand what part of the course the learner completed, whereas SCORM can only record scene and slide numbers.

2018-03-19T16:19:19.729	Ronan Burke correctly answered 'Question Scene3_Slide5_FreeFormPickOne_0_0' with response 'i'
2018-03-18T20:28:14.763	Michelle Byrne correctly answered 'A Wide Area Network is typically owned and managed by _____.' with response 'choice_6W0DHyxs9DB' with score 11
2018-03-18T20:27:27.560	Michelle Byrne experienced 'A Wide Area Network is typically owned and managed by _____.'

Figure 56: SCORM Exam Record vs. xAPI Exam Record

As can be seen in figure 25, the xAPI entries clearly state and allow admins to see exactly what question the learner is answering, while the SCORM entry provides no name, only scene and slide number. In courses which are extremely large, it may be difficult and time consuming to interpret what question a user has answered on a SCORM course, while with an xAPI course, regardless of the size of the course, the admin will always know which question the user has answered.

One other advantage with xAPI is that it records its entries in the Learning Record Store in real time meaning as a user moves from one slide to another an entry will be made. However, with SCORM, entries are only made once the user has closed the course. Another

disadvantage of this is that, if a user forgets to close a SCORM course once they have finished, no information about their attempt will be available to analyse. Overall, the evidence exists as to why xAPI is a better standard and it is substantial.

One major recommendation I would make regarding this project, is the need for a larger user group. Due to the restrictions of the SCORM Cloud account only allowing 10 users in total, only 8 users could be assigned to partake in the project user stories. The fact that there are 3 different user stories, each with a SCORM and xAPI version, meant that only 2 users maximum could be assigned to each course, with only 1 user being assigned to each course of User Story 3. If the user group was much larger, the level of analysis and the results which could be interpreted from course attempts would be far superior. With only two users or less taking all of the courses designed for this project, a lot of speculation is required in order to carry out the interpretations. However, if there were more users, patterns would begin to form and become visible for the admins to see, thus allowing them to make extremely informed decisions regarding actions to take to improve the learning experience for their learners.

Section 8: Final Project Report

Final Project Report

<u>Approach Taken</u>

This project began in September 2017. Once the project topic of e-learning had been chosen in the first week of semester 7, the first plan of action was to carry out the initial research into the area. It was during this phase of research that the history and benefits of e-learning were uncovered. E-learning is such an important area due to the manner in which it has transformed the educational and business worlds. Teachings and trainings can be carried out anytime, anywhere, on any device. It is clear that e-learning is an industry which evolved and improved since the term e-learning was first coined back in 1999, and it will continue to do so for the foreseeable future. The main objective of the initial research phase was to learn some background on your chosen topic area, but also identify some areas which need to be investigated. Areas that were selected for further research included the benefits and potential drawbacks with e-learning, market leaders and most importantly e-learning standards. The direction which the project would take was still unclear at this phase, however a research plan was designed to further investigate the highlighted areas.

The next step of the project was to carry out a literary review on the area of E-learning. In this piece of research, areas such as e-learning in education and business were broken down and explored, along with e-learning content types, methods, and pedagogies. The financial aspects of e-learning were also investigated such as the costs of hosting a Learning Management System in house or in the cloud. It was through the research carried out for the literary review that the project began to take shape. When examining the topic of e-learning standards, the battle between the SCORM and xAPI e-learning standards stood out. SCORM,
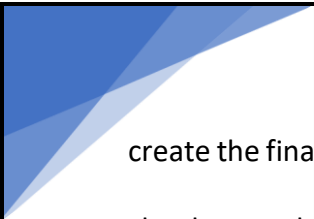
the much older e-learning standard, was still the most popular choice in reference to the authoring of e-learning content, even though the Experience API standard was newer and claimed to have benefits than SCORM. After looking further into the issue of e-learning standard options, it was decided that this area would play a key role going forward. The choice was made to use two different pedagogies, which were also uncovered during the literary review, and use both the SCORM and xAPI e-learning standard to author content. An e-learning course would be created for pedagogy. Each course would then be published once in adherence with the SCORM e-learning standard, and once in adherence with the xAPI e-learning standard. Many different pedagogies were uncovered during this research. However, the two pedagogies that were chosen for the project were Problem Based Learning and Scenario Based Learning. Now that the project had a backbone, information regarding e-learning applications and e-learning authoring tools was sought. Research was conducted to find out what Learning Management Systems existed and what each of these Learning Management Systems did. The Learning Management Systems which were examined were Edmodo and Moodle which were the two most popular Learning Management Systems software applications at that time. Authoring tools were looked into briefly, with one in particular called iSpring Suite. The literary review was concluded and the project idea of testing the two most popular e-learning standards using different pedagogies was developed.

With the project idea set out and approved, it was time to investigate technologies which could be used for the implementation phases of the project. The technology review contained investigations into areas such as e-learning authoring tools, Learning Management Systems, and Learning Record Stores, which are required for the use of the xAPI e-learning standard. The authoring tools which were tested during this stage were iSpring Suite 8.7 and Adobe

Captivate 2017. After testing both tools and creating a test course in each, iSpring Suite appeared to be the superior option to choose for creating e-learning content. The Learning Management Systems which were tested were Moodle Cloud, Docebo, ProProfs Training Maker and SCORM Cloud. When seeking a Learning Record Store, it was found that SCORM Cloud actually has one built into it, which would negate the need for using a separate Learning Record Store. Learning Locker was the other Learning Record Store which was tested, however it was difficult to set up and use, unlike the SCORM Cloud Learning Record Store which could be accessed at any time through a URL. For this reason, along with the fact that SCORM Cloud, as a Learning Management System, was easy to use and provided a free subscription with no expiry date, unlike other Learning Management Systems, SCORM Cloud was chosen as the optimal choice of both Learning Management System and Learning Record Store. A project panel review for the technology review was scheduled a week after the report had to be submitted. It was during this review that one of the panellists recommended looking into an authoring tool called Articulate 360, as it may be more beneficial to use that iSpring Suite. After testing Articulate 360, it was clear that this was the authoring tool which should be used. While both tools were only trial versions, the Articulate trial is double that of iSpring Suite with a trial period of 60 days. Articulate 360 also proved to be much more flexible. With Articulate 360, multiple different scenes could be created. There could then be graded questions throughout these scenes at different points, with the ability of having one or more results slides shown throughout different sections. Furthermore, Articulate 360 provided an extensive library of photos, illustrations and characters, and a wider range of question types to help create intricate courses, exams and settings which iSpring Suite did not.

With the initial research, literary review and tech review all complete, the time had come to
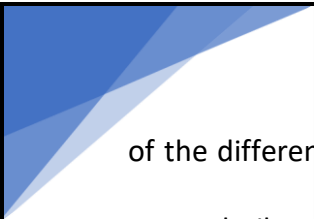
create the final project proposal. In this proposal, the plan for the implementation phases was clearly stated. Objectives, technical requirements and a risk assessment were all included in the final proposal. The proposal outlined the plan of creating SCORM and xAPI versions of Problem Based Learning and Scenario Based Learning courses, and test and compare them to see which of the two most popular e-learning standards was the superior. The main objective of this project and the target audience was also mentioned in that it stated that the objective of this project was to help identify which E-Learning standard is better suited for Problem Based Learning, and Scenario Based Learning, and that the hope was that content creators will be able to use such information in order to better their E-Learning courses and content which use both of these pedagogies. It was described how the courses created would be hosted on the SCORM Cloud Learning Management System and assigned to different user groups in an attempt to test the usability, accessibility, responsiveness and reliability of the e-learning standards.

Come February 2018, the project proposal had been accepted, and it was time to being working on the first iteration of the project. Before carrying out the objectives for this iteration, Problem and Scenario Based Courses were studied in an attempt to understand how to create these course in the most efficient and effective manner. Articulate 360 is also a very complex tool, therefore, before creating content for the project, many different visual and text tutorials were completed in order to ensure that all useful features were known so that the best courses possible could be created. Once all the prepping was completed, iteration 1 began. SCORM Cloud, only allows a maximum of 10 users on its free subscription. As there were already 2 test accounts in existence on it from the technology review phase, and due to the fact that users cannot be removed, 8 users would be participating in this project. In the

meeting held at the beginning of February to assess plans for the first iteration, it was decided that, rather than just having two user stories, a third user story would be added which would be a course that incorporated elements of both Problem Based Learning and Scenario Based Learning pedagogies. All three user stories were planned out in detail. It was decided that the first would be a Problem Based Learning Networking course which would contain content for people new to the area of Networking. The second user story would be a Scenario Based Learning Work Ethics course, while the final course would be a Mathematics Shopkeeper Scenario Course that attempted to combine Problem Based Learning and Scenario Based Learning. All 3 user stories were developed using Articulate 360 and were hosted online on the SCORM Cloud Learning Management System. The next step was to recruit the user groups. In an attempt to keep results as true and pure as possible, the eight people that were selected had no knowledge of the areas covered in the user stories. It was going to be new material for them all to interact with. Due to there being eight people, originally the plan was to split it evenly and have two groups of four. However, with the introduction of a third user story, there needed to be 3 groups. Therefore, user group 1 and 2 contained 4 users and, due to availability of the user group as a whole, one user from group 1 and group 2 were selected to also be members of user group 3. In user group 1, two users were assigned the SCORM version of the Networking course, and two were assigned the xAPI version. Similarly, in user group 2, two users were assigned the SCORM version of the Work Ethics course and two were assigned the xAPI version. With user group 3, one user was given the SCORM Mathematics Shopkeeper Scenario course, with the other receiving the xAPI version. At the end of each course, there was a button which would link to a user experience survey. These would be used in an attempt to determine the usability, accessibility, responsiveness and reliability
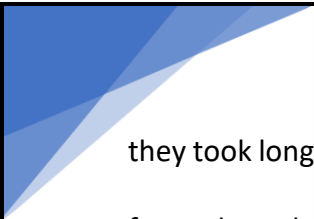
of the different versions of the courses. The main objective of this iteration was to get the course built and show that information about the courses could be recorded and used, along with user experience survey feedback, to determine which standard fared better over the other based on these four metrics. The results of this analysis were recorded and documented, however, one thing which stood out was that there was a notable difference with regards to what each standard could record about a learner's course attempt. Pushing forward to iteration 2, it was noted that this area would be a main focal point. The user feedback was documented for each course, with the plan being to improve the courses based on this feedback and then observe, in-depth, what type of information can be recorded by SCORM and xAPI.

For the iteration 2 stage, improvements were made to all courses. The Networking Problem Based Learning course's navigation was redesigned to make it more efficient, a branched exam was added to cater for learners who are not as strong in a particular area, or as good at retaining information as others. A fifth scenario was written and designed for the Work Ethics course as requested in the survey feedback, and finally, four more mathematical scenario problems were created, and the items menu was redesigned to contain double the number of items in the Mathematics Shopkeeper Scenario Course. Once again, the revamped courses were hosted on the SCORM Cloud and assigned to users. A great feature of the Learning Record Store is that it records both SCORM and xAPI logs in the one place. Once all users had taken the courses, the logged events in the Learning Record Store were analysed. It was here when it was discovered that the SCORM e-learning standard was not capable of recording as much information as the xAPI standard. SCORM could only record graded question slides and a final percentage, whereas xAPI could record so much more. The xAPI standard had a major
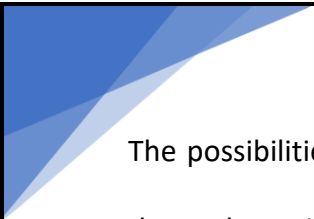
advantage over SCORM in that it could record logs such as timestamps of all events, when a user accessed a slide, the name of the slide accessed, the question that was asked and the answer that was provided on questions slides, the score a user received for an answer to a question, whether they had passed the course, and all of these were recorded in real-time as they were happening, whereas SCORM only logs entries once a course has been closed by the user. A table was created indicating the different recording features that each e-learning standard possessed. It was clear at this stage that the xAPI standard appeared to be a superior choice than SCORM for creating e-learning content. However, although the table illustrated what each could record, there was a strong feeling that it would be possible to put this in to practice and show, through visualisations, what each standard could record about the 3 user stories that existed, and what type of analysis and conclusions could be drawn from such recordings about learners. Therefore, the goal for iteration 3 was demonstrate this.

Tableau, a data visualisation tool was used in iteration 3. A datasheet was created in Excel for the SCORM and xAPI versions of each course. The SCORM datasheets contained information such as users and their final percentage, and the exam questions and whether the user answered them correctly or incorrectly. These were the only two meaningful pieces of that which SCORM records that could be visualised. These visualisations do not tell much about the learners themselves. However, the xAPI datasheets on the other hand contained information such as user and their result as a percentage, whether they passed or failed the course, the length of time they took to complete the course, the length of time they spent on each section within the course and the score they received for each graded question in the course. With xAPI, an administrator or teacher can learn so much about their learners. The time it took to complete each section of a course can be visualised to interpret which sections

they took longest to work through. From this, it is possible to then review the scores received for each graded question and map that question back to the section it was based on. If a user has incorrectly answered a question, it can be linked with the time that user spent on the section from which that question was based. From there, it can be interpreted whether it was down to user error such as the possibility that the time spent on that section was very low meaning they may have rushed through it and not paid full attention to it, or if the time spent on that section was relatively higher than expected, it could be a sign that this user is struggling with that particular section. With more users, patterns may begin to develop. For example, if a large number of users are getting the same question in an exam wrong, it could be an indication that perhaps the section which the question is based on is written in a complicated way, or is too long to maintain learners' attention spans, or simply that it is not facilitating the learning of the user. Either way, it can indicate that this particular part of the e-learning content needs to be modified or improved. The xAPI e-learning standard helps to identify learners' strengths and weaknesses. By analysing data, you can see in which topics or areas users flourish and languish. Using the Problem Based Learning Networking course as an example, if the administrator can see that a user appears to be struggling in the area of networking hardware, they could assign a new course to that user which could help them better understand that area, or they could reach out themselves and offer to help them understand it. All learners are different and, in iteration 3, it was demonstrated how the xAPI standard allows administrators and teachers to cater to their learners on a more personal level. With xAPI learning patters, strengths and weaknesses can all be uncovered, along with the realisation of which type of e-learning works best for individual learners. Perhaps one learner takes in knowledge easier through videos in the courses, while another retains information more easily when there is a question after each slide to check for learning.

The possibilities regarding the analysis that can be carried out about courses and learners themselves with the xAPI standard as opposed to SCORM appear to be plentiful.

Project Review

There were seven main project lifecycle phases throughout this project. Each phase was crucial and helped shape the project in its own way. The first phase was the initial research phase through which the different areas of e-learning were uncovered and flagged for further investigation.

The literary review, which was the second phase, allowed for the exploration of many different areas of e-learning in an attempt to give the project direction, which it achieved. The literary review highlighted the battle for supremacy between the two most popularly used e-learning standards SCORM and xAPI and steered the project towards them.

 The third phase in the project lifecycle was the technology review. This phase allowed for testing of different technologies to determine which would be the most useful implement the project and bring it to life.

The next phase was the final project proposal. It was here when the idea for the project had to be broken down and dissected to assess its feasibility and practicality. This phase allowed for a detailed explanation of the direction of this e-learning project and the objectives that it set out to achieve. The final project proposal was crucial as the idea needed approval and, once that approval was provided it meant a lot to know that the previous months of hard work on the other phases of the project was worthwhile and it enables confidence in the idea that this project has a clear direction and is worthy of moving forward to the implementation

phases.

The fifth project lifecycle phase was the first iteration of the project prototype. This phase was important as it was all about getting the project idea up and running. In iteration 1, the main objective was to analyse the courses based on usability, accessibility, responsiveness and reliability. While doing so, another serious topic presented itself regarding what each standard could record. This information would set the scene for the next phase and allow for the improvement and furthering of the project.

The sixth lifecycle phase was iteration 2. This iteration provided major insight as to the vast difference between what each e-learning standard could record about the course and learners' attempts of the course. It was the analyses and findings of this section which would set up the project finale in iteration 3.

The seventh, and final phase of the project lifecycle was iteration 3. In this iteration 3, both e-learning standards were fiercely analysed and tested using visualisations in Tableau with the objective of showing what data analysis, interpretations and results can be conducted and drawn from the logs which each e-learning standard can record. It is evident that trough iteration, one e-learning standard was found to be the better choice over the other for multiple reasons. This final phase allowed for the conclusion of 8 months of investigation, documenting, recording results, analysing results, visualising data and highlighting whether e-learning administrators and authors should use SCORM or xAPI for the assigning and creating of e-learning content and why.

While the main objective of comparing SCORM and xAPI never changed with this project, there were several changes between what was originally proposed and what was finally

designed and implemented. Prior to the final project proposal, the tool that were going to be used were SCORM Cloud for hosting the content and iSpring Suite for creating the content. However, once Articulate 360 was discovered, a necessary change had to occur. For the bettering of the project, iSpring Suite was to be removed and Articulate 360 was to be the new authoring too due to its superiority. Originally, the project plan was to create two courses and publish them once for SCORM, and once for xAPI. The original plan was to also test the standards with regards to usability, accessibility, responsiveness and reliability. However, by the conclusion of iteration 1, these questions had already been answered and there was a much more important and meaningful question that arose regarding what each e-learning standard could record. The project was no longer solely about testing the standards based on four metrics, it was now diving deeper into what logs the standards recorded and what analysis could be performed on each and what conclusions could be drawn from data interpretation and analysis. While the destination of this project never changed, the roads travelled did, and for the better. It was still determined which e-learning standard was superior, however, the reason as to why became much more in-depth and satisfactory due to the change in direction at the close of iteration 1.

Conclusion and Recommendations

Overall, this project set out to determine whether SCORM or xAPI was a better choice of e-learning standard for e-learning authors and administrators to use. In the end, the project achieved that goal. It was determined that xAPI was the better option due to the level of data it can record and how that data can be used to better the e-learning courses and the learning experience of every user in the system. The xAPI data helps administrators and teachers make

more informed decisions about what courses their learners should be assigned and allows them to uncover strengths and weaknesses that learners have within a particular module. Based on strengths and weaknesses that learners possess, the administrator can tailor modules and e-learning courses to help learners improve in the areas which they may be weaker in. Overall, the xAPI standard appears to be a better option than the SCORM standard due to SCORM's limitations regarding the information that it can record.

One major recommendation that can be made in order to improve the results of this project is to carry on with a much larger user group. Due to the fact that it was only a maximum of 2 users partaking in each course in this project, it was difficult to draw conclusions from the data about the learners and the course. If there were more users in each group, more clear patterns would begin to emerge. There would be a larger population of learners to compare data on. If there are many learners struggling in the one area, they could all be grouped together to be part of a new user group and then a course which will help them strengthen that weakness could simply be assigned to the group. A greater indication of how long the courses take to complete and the average time spent on different sections of the course could also be gained. Overall, with a larger group of learners to participate in this research, the results and interpretations on the data would become more meaningful and more conclusive than it could be with only 2 users in a group.

Another recommendation for the future with this project would be to also closely examine the times that learners spent on each exam question in the xAPI courses. This is another valuable piece of information which could provide insight as to which questions are the hardest by examining which questions in general take the longest to answer. This could then be mapped back to the section on which that question is based, which may need to be

simplified or reworded so that learners better understand the content that is being presented to them.

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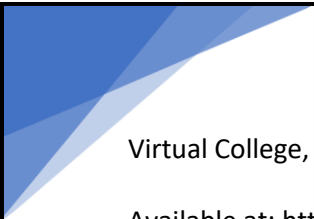
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