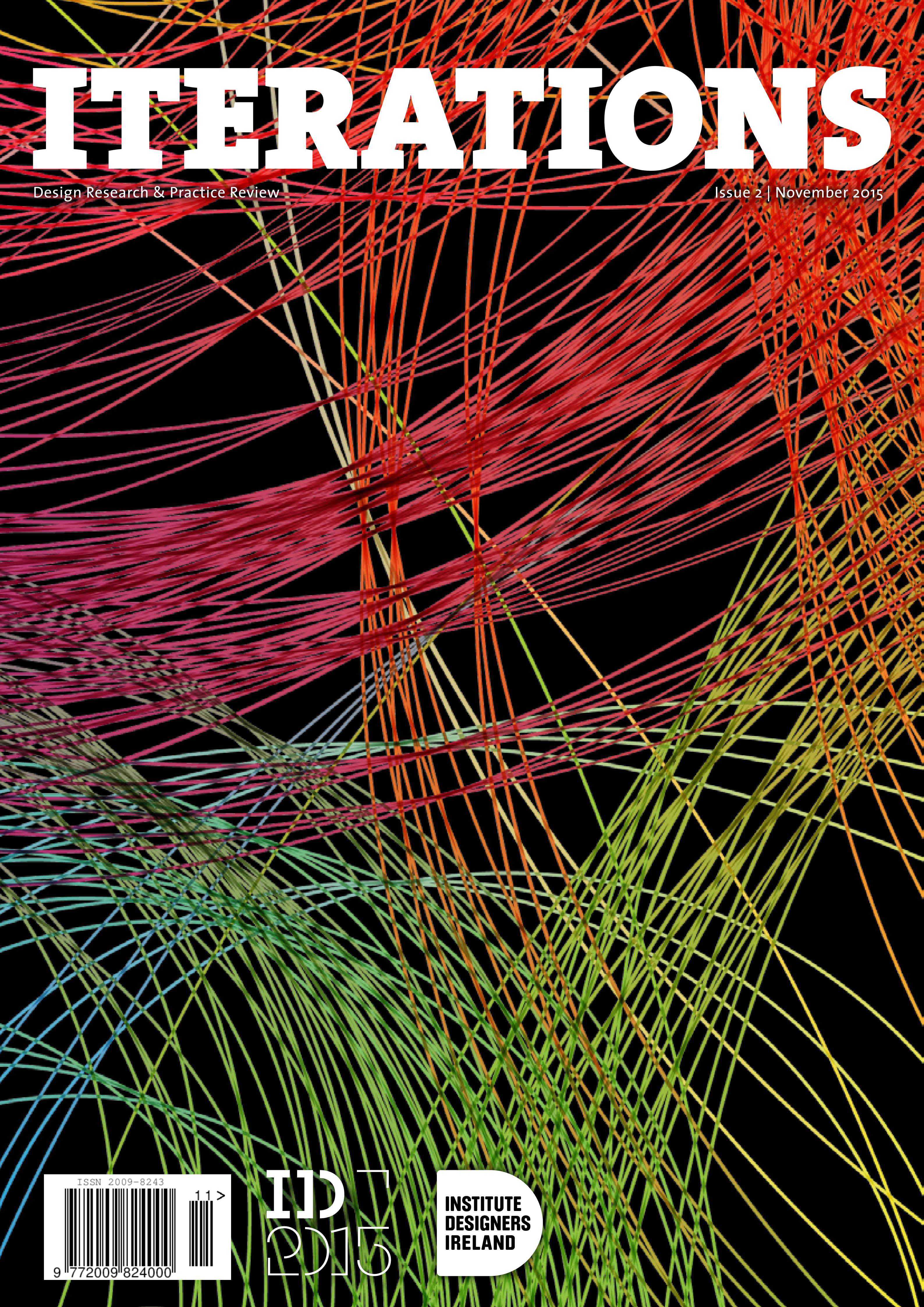

ITERATIONS

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Digital Training Resources

An exploration into the development, need and use of digital medium resources in a pre-defined training process

This project explored the dangers associated with the use of woodworking machinery in the context of training beginners while also examining the current resources on offer. A theoretical review was informed by analysing and utilising an existing machine training process within Galway-Mayo Institute of Technology, Letterfrack (GMITL) as the basis for any proposed solutions. Research also explored how students learn in practical curriculum alongside the benefits of technology enhanced learning environments in such situations. The project proposed solutions to improve the GMITL training process through the design, development and use of two digital medium strands, one for Activity Tracking (AT) and the other as a Digital Learning Resource (DLR). The development of the DLR was aimed at supplementing beginners learning not only in GMITL but also in the woodworking industry, meaning the benefits are felt wider afield. The development process was validated by a range of testing methods to help validate if these digital resources were of benefit to the woodworking industry.

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Introduction

Training students to use highly dangerous woodworking machinery makes it imperative that students have the best possible learning resources. This project explored a machine training process in Galway-Mayo Institute of Technology Letterfrack (GMITL), a Higher Education Institute in Ireland. The intent was to identify opportunities for improving training resources by utilising the transformative qualities of digital medium. The project explored the dangers involved in this industry, existing resources, learning styles and the benefits of technology enhanced learning alongside an analysis of the existing GMITL training process.

Rationale

The rationale evolved through personal experience working as a lecturer in GMITL while training students to use woodworking machinery. The driving force was the disparity between the level of information that was provided to students and the observed limited retention of this safety critical information. GMITL has a proven track record training students on machinery without recording an accident in its 25 year existence. However, as the Higher Education landscape changes, the exposure time for students to these machines has been lowered. Couple this with a need to accurately document students training to ensure both the validity and integrity of this process, it provides a strong catalyst for this project. If GMITL was challenged on a student's training, the quality control mechanisms in place were both outdated and liable to human error.

Objective

The objective of the project was to design and develop an improved set of training resources and quality control framework. This will ensure the highest quality of training that is offered by GMITL continues into the future. The aim of these resources was to improve knowledge retention. By focusing the project on an existing training process it allowed the outcome to be designed to the needs of GMITL and address existing issues within the training framework.

Research and literature

Training in GMITL

It was important to first understand the GMITL machine training process that this project worked within. The majority of machine training takes places in Year 2 of a Level 7/8 degree programme in a module titled Manufacturing Technology 2. Machine training is delivered by 5 separate lecturers through a theory lecture, MCQ test, practical demonstration, practical test and a practical project (Figure 1). Each student is taught by a minimum of two lecturers who are responsible for different elements of their training and record keeping. A simple paper based sign-off system was utilised for the practical training element which formed a student's training record. This paper based system was by no means efficient and raised quality control concerns.

Health and safety in the woodworking industry

As no official standards or industry specific statistics exist in Ireland, information was gathered from the Health & Safety Executive (HSE UK).

"Woodworking is the only industry where machinery accidents cause more injuries than slips and trips. Around 25% of these are classed as major injuries. Accidents can be caused by either contact with the moving parts, including tools, or kickbacks of timber and ejected cutters. This happens because of inadequate guarding and poor systems of work, often resulting from insufficient training." (HSE UK, n.d.)

PUWER 98, the UK Code of Practice for the woodworking industry, states each year that there can be as many as 800 accidents in the UK industry, a statistic that is nearly twice the rate of any other industry (HSE UK, n.d.). Realising the dangers at play, it is critically important that GMITL offer the highest standards of training possible.

Training Frameworks

PUWER 98 provided guidelines for training woodworking machinists and suggests a process of how training should be completed. When compared with the GMITL process (Figure 1) the main difference highlighted was that GMITL always trained students from first principles while PUWER 98 proposed an alternative process for experienced operators.

PUWER 98 also specifies a 4 step checklist for developing in-house training.

Step 1:	Establish aims
Step 2:	Design training package
Step 3:	Setup assessment procedure
Step 4:	Record what you have done

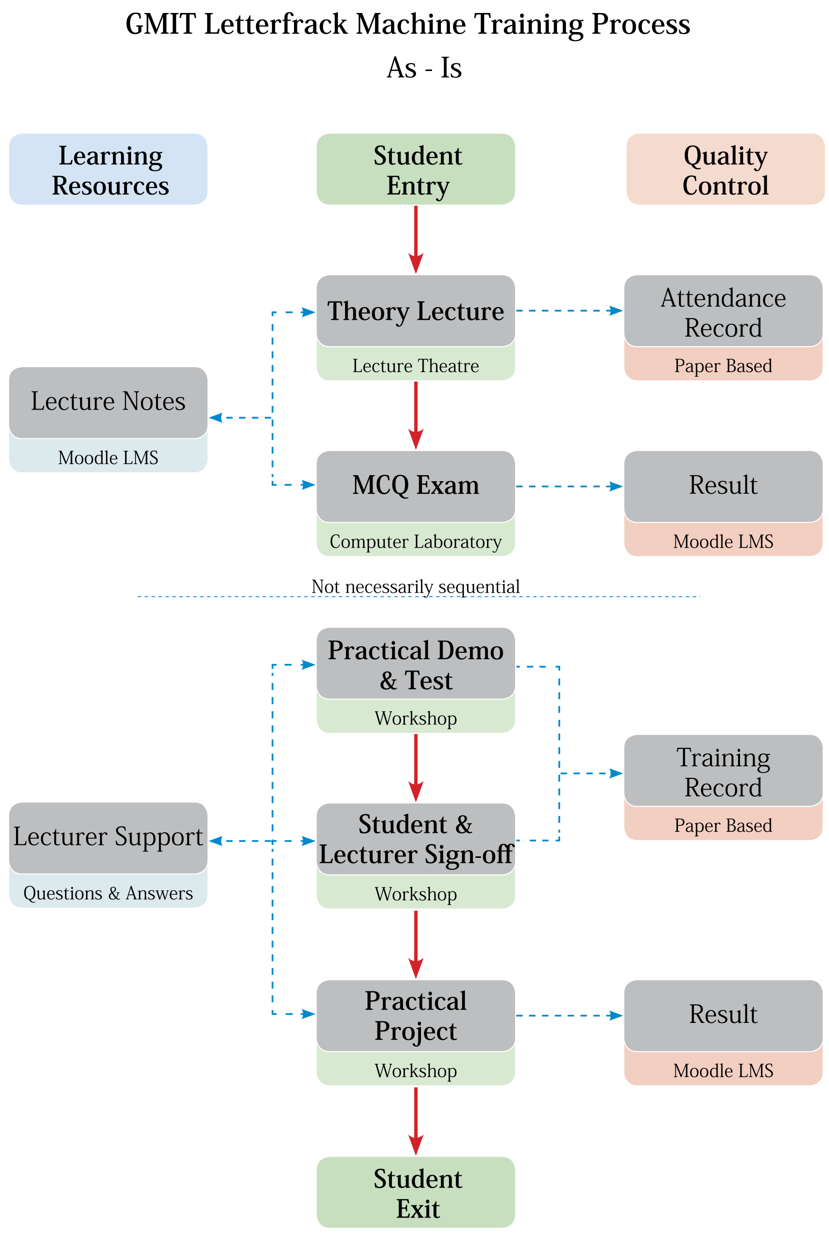

Figure 1

From the objectives defined, Steps 2 and 4 of this checklist provided the project focus. Step 1 was established by the students GMITL teaches and the aims of the module already in use. Step 3 was covered in the training framework process (Figure 1) and the assessment elements were identified in sign-off sheets.

A comparison between GMITL sign-off sheets and industry alternatives showed multiple similarities emphasising the belief that the GMITL training framework was appropriate and within safe working practices. The intent of this research was to further improve those working practices and learning resources.

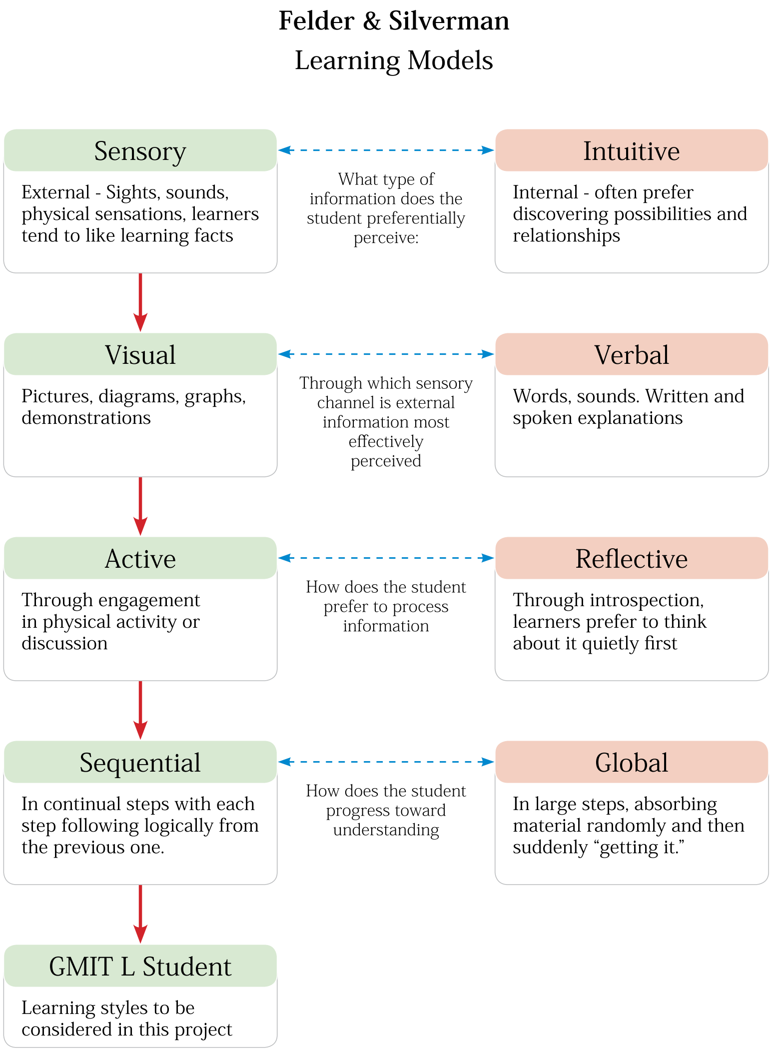

Figure 2

Learning styles

To develop a successful learning resource it was important to understand how students learn. Research into learning styles discovered intense discussion about the validity of such styles or the lack thereof (Coffield et al., 2004). Some of the main learning styles in play are Kolb (1984), Gregorc (1982), Felder–Silverman (1988), Fleming (2001), and Dunn and Dunn (1989) among others.

Having researched multiple learning styles it was evident that all students learn in different ways (Hawk et al., 2007). If this resource was to be successful it should utilise multiple approaches to teaching and learning to ensure an optimal learning environment was created for all (Felder & Silverman, 1988).

Students at GMITL study highly practical courses which would be akin to those of engineering students. For this reason the Felder and Silvermann model which was based on learning and teaching styles in engineering education was taken as the preferred framework. Figure 2 summarises the categories that students fall into within this model and proposed categories that were considered for a GMITL student according to Felder and Silvermann's (1988) definition of an engineering students learning style.

"Many or most engineering students are visual, sensing, sequential and active" (Felder & Silverman, 1988).

Taking these learning categories as a guide their relevance to the GMITL machine training process was explored.

Sensory

Sensory learning is how a learner perceives the world around them mainly through sight (Felder & Silverman, 1988). GMITL provides sensory learning through the use of practical demonstrations that reinforce theory based lectures.

Visual

Visual learning relates to the use of images, diagrams, flow charts etc. that can supplement textual and verbal material. Visual learners often find it difficult to process volumes of verbal information with most adults preferring visual learning (Felder & Silverman, 1988). GMITL has verbal and textual based information in the form of lectures but they lacked a comprehensive set of visual imagery to support the learning outcomes.

Active

"Active learning is generally defined as any instructional method that engages students in the learning process. In short, active learning requires students to do meaningful learning activities and think about what they are doing" (Prince, 2004).

Students in GMITL are engaged in active learning on a regular basis. Active learning is combined with kinaesthetic learning where students are tasked with making a piece of furniture with knowledge attained. This is considered Project-Based Learning (PBL) and according to Prince (2004) results have shown it can nurture a deeper approach to learning and help students retain knowledge longer. Active learners do not retain much information in traditional lecture environments (Felder & Silverman, 1988) thus necessitating the need for active participation.

Sequential

Sequential learning revolves around step by step progression from a generally basic start point through to more complex examples (Felder & Silverman, 1988). This is an obvious component of the training process as the use and setup of machinery is generally sequential. However, when students forget a step they passively attained information from the lecturer meaning their retention of that information was generally minimal. This project offered an opportunity to introduce an active learning segment within these sequential steps to help improve knowledge retention.

Technology Enhanced Learning (TEL)

TEL is any process that utilises some form of technology to make learning more effective, efficient or enjoyable (Goodyear & Retalis, 2010). It differs from e-learning where elements of learning have to be completed online. While e-learning is growing it still has problems with most platforms only containing e-information as opposed to learning resources (Race, 2005). Due to the dangers of machine training it cannot be performed online, making TEL the optimum solution. The medical industry has broken this paradigm by utilising virtual reality environments which have been proven to significantly improve surgeon's performance (Seymour et al., 2002).

The use of technology in classrooms has grown with many examples of its success when integrated with traditional teaching styles (Grabe, 2007). Technology has also been embraced in industry and military to aid training but how to measure its effectiveness is still up for debate (Salas & Cannon- Bowers, 2001). To ensure TEL is successful a *'SECTIONS'* model has been developed (Figure 3) to help choose the most appropriate technology (Bates & Poole, 2003). It is also imperative that you design any technology resources in the context of the entire course and not as a standalone entity (Laurillard, 2002). This ensures newly developed resources support and supplement existing teaching methods.

Learning Management Systems (LMS)

Learning Management Systems (LMS) such as Moodle and Blackboard are being integrated into higher education at a rapid pace but have mainly been utilised for administrative tasks such as document storage (Lonn & Teasley, 2009). Studies have shown that more interactive learning tools need to be created to improve LMS (Lonn & Teasley, 2009). LMS are highly efficient for document management but have had a limited impact on pedagogy with Dalsgaard (2006) suggesting their use should be limited to administrative duties only. Dalsgaard (2006) also suggests developing independent web applications that work alongside LMS which promote active learning and allow students to refer to information after they have completed their education.

Existing resources

The woodworking industry unlike the medical industry as mentioned above has not seen investment in digital resources. Resources available include mainly text based information with some visual imagery. The visual imagery is usually black and white or photographic records of machinery which can prove difficult to decipher.

GMITL resources include lectures made available on a LMS, books within the library (of which many were outdated), the physical machine in the workshop and lecturer or technician support. The limited demand for books means a lot of literature available is text heavy and outdated. While, within the workshop the only resource available

Figure 3

S	**Students:** What is known about the students?
E	**Ease of use and reliability:** How easy is it for students and staff to use? How reliable is the technology?
C	**Costs:** What is the cost structure for each technology? What is the unit cost per learner?
T	**Teaching and learning:** What kinds of learning are needed? What instructional approaches will best meet these needs?
I	**Interactivity:** What kind of interaction does this technology enable?
O	**Organisational barriers:** What are the requirements and barriers that need to be removed to use this technology?
N	**Novelty:** How new is this technology?
S	**Speed:** How quickly can a course be built with this technology? How quickly can materials be changed?

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DLR PACT Analysis
People, Activities, Context, Technologies

People

Lecturers/Academics
Trainers
Students - 18 - 24
Students - Mature, 24+
Industry Professionals
Hobbyists
Other interested parties

Must satisfy a range of skills, ages and backgrounds

Activities

Knowledge reinforcement
Problem solving
Machine setup/use
Learning process
Study aid
Demonstration tool
Teaching aid
Research activities

Must satisfy an array of activities

DLR PACT Analysis

Context

Workshop
Office/studio
Home
Lecture theatre
Commuting
Time pressure
Safety critical situation

Must satisfy a range of environments and situations

Technologies

Desktop
Laptop
Tablet
Mobile
Touch-screen
HTML/CSS/JavaScript
Mainstream technologies
Modern browsers
Responsive platform

Must utilise mainstream tech that are supported on multiple devices and platforms.

Figure 4

to students is verbal information passively attained from a lecturer or technician.

A large range of information is available on the web with video content on streaming sites but the accuracy of some of this information is questionable and very difficult for a student to decipher its reliability.

One of the best resources available to students is from the Health and Safety Executive in the UK (HSE UK) who have a dedicated woodworking page with multiple resources. However, the information in the website can be technical and this may be intimidating for a beginner.

Didac UK
Didac UK offer an e-learning and training certification system with multiple resources for woodworking machinery (Didac). It includes a range of its own imagery with the service being offered to trainees on supported courses for a fee restricting access to outsiders.

Research Conclusion
Research highlighted the dangers involved in the use of woodworking machinery, emphasising the need for high quality training. It also validated the GMITL training framework as within industry guidelines. Taking cognisance of this, project opportunities were identified:

1. Training records - paper based system required updating
2. Improved quality control - updated record keeping process required
3. Dangers - danger involved in the use of woodworking machinery must be considered
4. Resources - available resources do not satisfy identified learning styles
5. Visual material - lack of clear and up to date visual material
6. Active learning - new resources should promote active learning
7. Technology enhanced learning - utilise digital mediums to support learning
8. Centralised resource - include collated valid information from external sources

Focus
After considering the identified opportunities the project was split into two strands. The first aimed to improve the quality control aspects of GMITL machine training records by developing Activity Tracking (AT) in a digital medium. The second focused on developing a Digital Learning Resource (DLR) with an emphasis on visual material. The DLR also offered further opportunities to integrate active learning within the training process.

Approach
The AT and DLR strand were considered pieces of software that would be integrated within the GMITL machine training process. A business process modelling tool (As-Is/To-Be) was used to analyse the AT strand by examining the existing GMITL training process (Figure 1). The DLR strand required interactivity for users to feel they are playing a part in their learning making a human centred approach essential. A PACT analysis was completed to do this with

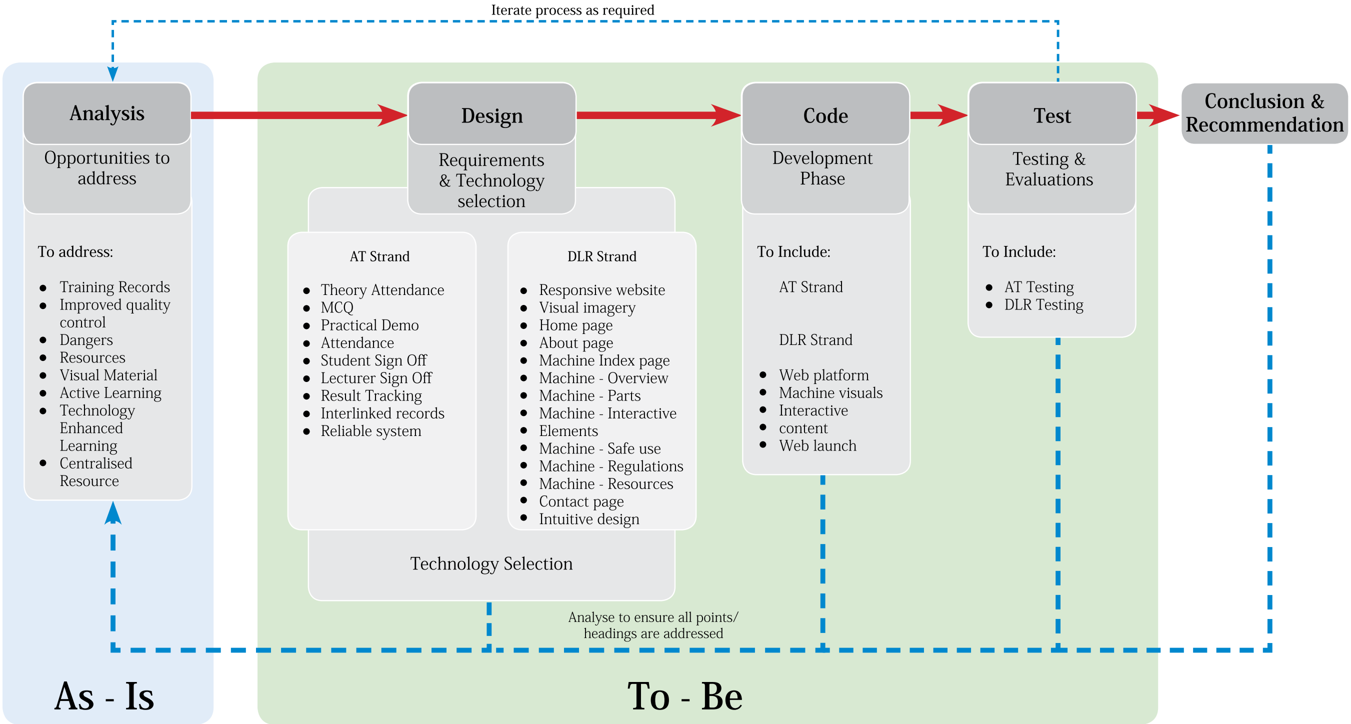

Figure 5

results shown in Figure 4 (Benyon et al., 2004). Consideration was given to the user experience when developing interactive elements as inefficient or defective interactions would deter potential users (Preece et al., 2002).

Requirements

To progress the project to the development stage, a defined set of requirements for each strand was established alongside a project framework diagram (Figure 5).

Technology

Taking consideration of the project requirements a suitable piece of technology was chosen for each strand.

Activity Tracking (AT)

After reviewing literature and consulting with GMITL IT technicians, a decision was made to utilise Moodle, the existing LMS within GMITL. All stakeholders were already familiar with this LMS minimising the learning curve while also linking their machine training records with their existing student records.

Digital Learning Resource (DLR)

Considering the examples found in literature it was decided that the machine visuals would be developed using vectors for clarity and scalability, Adobe Illustrator was the chosen software. The chosen piece of software to create the animated visuals was Adobe Edge Animate (AEA). It is aimed at developing interactive animations for the web using HTML, JavaScript and CSS.

Finally, a responsive website was required to make the visual material adaptable to multiple devices. After much research it was decided to use an open source framework called Bootstrap. Bootstrap provides a set of CSS and JavaScript files that work on all devices allowing you to build your site around them using HTML5.

Design development

Before commencement of the design development phase a review of the GMITL training process As-Is diagram (Figure 1) was considered. Taking research, project approach and requirements into account, a To-Be diagram was created (Figure 6).

When compared, it was clear from the As-Is diagram that the quality control aspect of the training was both sporadic and unlinked. The To-Be proposal created a solid structure to improve quality control by interlinking all elements in the AT strand. It also illustrates how the DLR would be integrated within the training process.

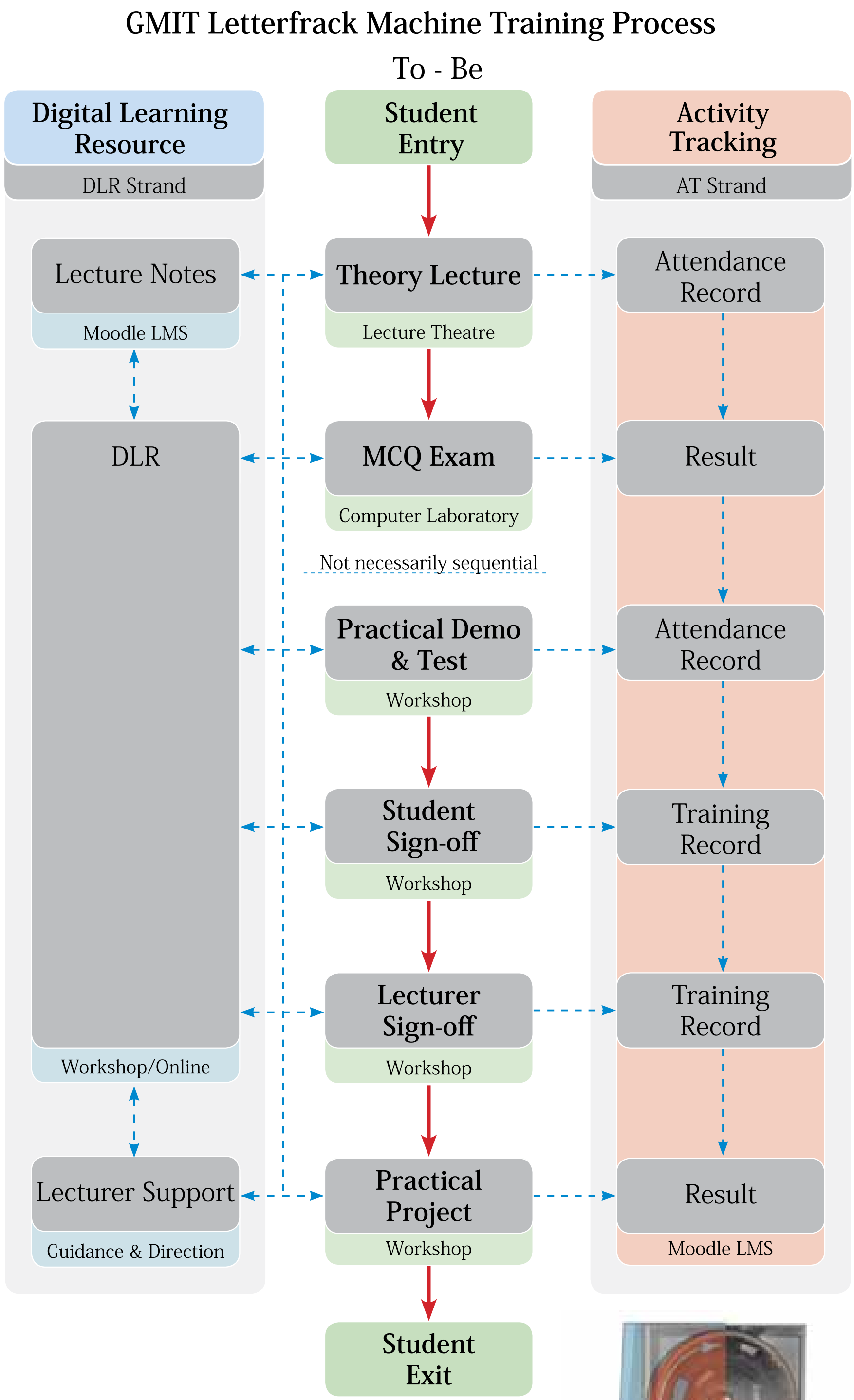

Figure 6

Activity Tracking (AT)

While researching Moodle, it was discovered that there was an inbuilt module known as 'Activity Completion Tracking' (Moodle Documentation). Using the To-Be diagram (Figure 6), the machine training process was digitised. The activity completion module allows you to link multiple Moodle elements that must be accomplished to complete the training process. The process will require student and lecturer input to ensure all learning outcomes are met. The final result of the AT strand created a reliable, linked digital record. It negates the use of paper records and creates digital records that can be cross referenced at any point, greatly improving the quality control procedures in place.

Digital Learning Resource (DLR)

Machine visuals

To create the machine visuals, all machines were photographed in high resolution. Secondly, using research and knowledge attained through experience working as a GMITL lecturer all relevant parts were identified. Each machine was then meticulously traced to include all relevant details to produce clean visuals.

Figure 7 presents a composite image of a machine and visual. By using actual imagery the scale and relationship of all elements is highly accurate. A simple palette of colours was used across all machines with similar parts colour coded. This decision utilised mental modes by allowing users to become familiar with a new machine from the first viewing (Benyon et al., 2004).

Animated visuals

To meet the DLR requirements, one animated visual that allowed to users learn about machine parts and another to illustrate its physical movements was required. These animations incorporated interactivity to help reinforce the learning that would take place.

Website platform

The Bootstrap framework formed the website foundation. Two important considerations that drove the development process was the need to make the website responsive and the navigation intuitive. The PACT analysis (Figure 4) highlighted the need for a responsive website due to the array of devices that could be used to access the DLR.

Figure 7

The need for an intuitive navigation relates to the environments that this resource could be used in. If a student is encouraged to actively seek out information while being in a safety critical situation the navigation needs to be intuitive, simple and quick. It also needs to work for touch screen devices as this is the most obvious choice for this environment. To satisfy this need a fixed navigation bar was chosen because studies have shown they can speed up navigation by 22% (Denney, 2012). Combined with this, all buttons were designed to be large in size to help with touch navigation and located in a consistent manner throughout the site minimising the learning curve.

Branding

Figure 9 shows the completed DLR which was branded WWrasp (Woodworking Resources and Safety Procedures) and can be accessed at: www.wwrasp.com

Intellectual property

The final consideration was the Intellectual Property (IP) contained within the DLR. After much deliberation and a reluctance to restrict access to GMITL students it was decided to offer the resource as an Open Educational Resource (OER). OER are teaching, learning, and research resources that are openly available with an aim to break down barriers of educational elitism (Atkins et al., 2007).

However, as the DLR contained valuable IP it was important to protect it. This was completed by using a Creative Commons licence which restricted its use to non-commercial entities. It offers a form of deterrent for anyone who may wish to profit from this IP but also allows interested parties to benefit from its content.

Testing

Activity Tracking (AT)

The AT strand was tested using a 'Quick & Dirty' method by means of an informal focus group with the main stakeholders, GMITL lecturers. This is a user-centred practical approach that yields informal qualitative results (Preece et al., 2002). The testing analysed this resource from four perspectives; problems of the existing solution, alongside the pros, cons and suggestions relating to the proposed solution.

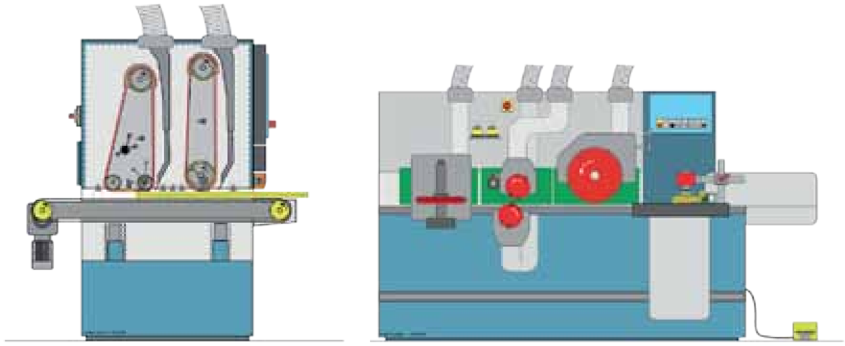

Figure 8

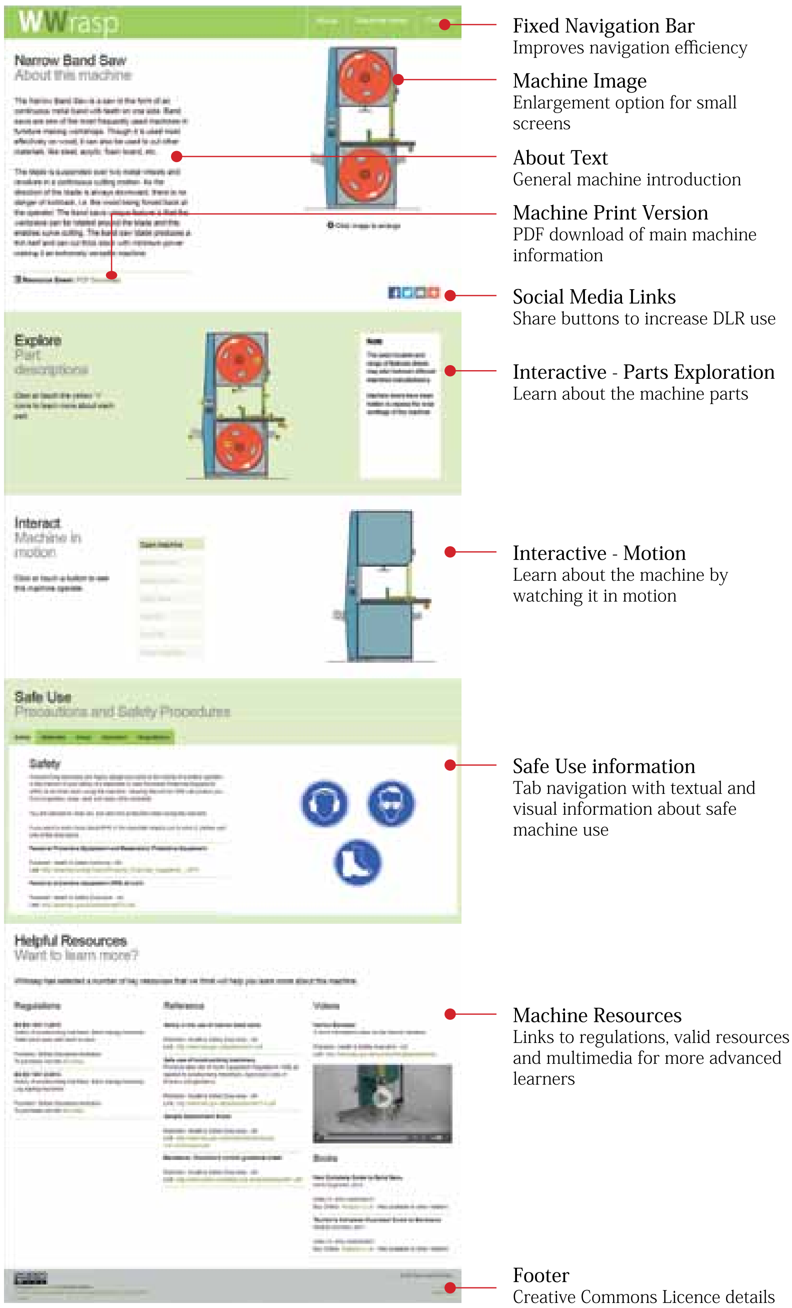

Figure 9

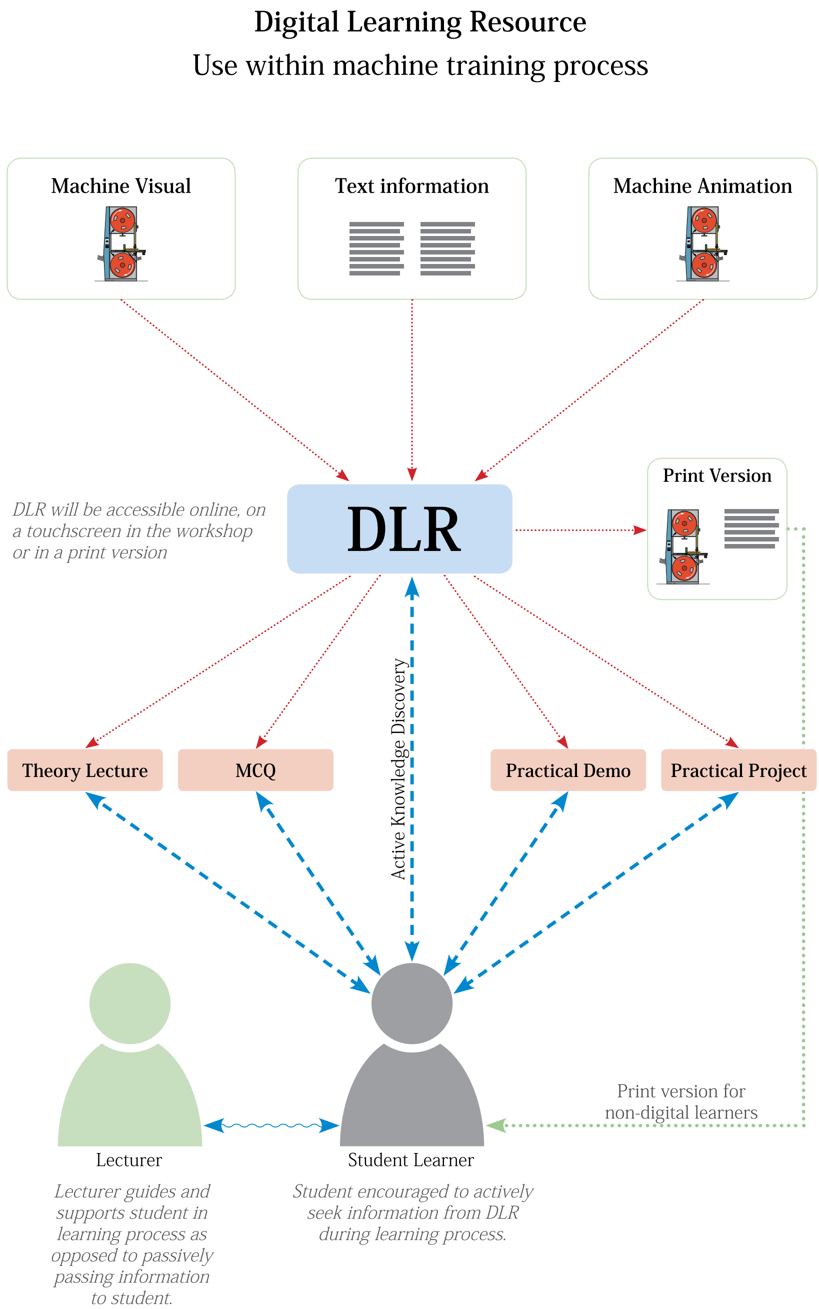

Figure 10

The proposed AT solution improves the quality control aspect of GMITL record keeping but also produces a system that can be cross referenced which was validated by testing. The focus group raised some issues with the continued administrative load however, re-designing the GMITL training process fell outside the project scope.

Machine visuals

As the machine visuals were being developed a print version was simultaneously developed to facilitate different learner's needs. The information contained in these resources was researched using multiple sources and required validation. To do this, hardcopy versions were reviewed by a senior lecturer in GMITL with feedback used to update the final DLR content.
A continuation of the 'Quick & Dirty' approach was utilised to evaluate the machine visuals. These were presented to the same focus group with commentary recorded on result sheets.

GMITL lecturers felt that the visuals far exceeded anything that is presently available and suited the students' needs, whom lecturers consider as mainly visual learners. It must also be noted that lecturers envisaged these visuals being used throughout the GMITL training process just as the resource had been designed (Figure 10) validating decisions made during the design development process.

Digital Learning Resource (DLR)
The DLR was tested using an online survey distributed to an array of qualified candidates. A total of 9 questions was developed receiving 45 responses. Considering the summary of results it is fair to state that feedback received was positive (Figure 11). The results validate the need and desire for this resource. 97% of respondents stated the DLR will be beneficial to the industry and 94% said they would recommend it.

The survey provided textual comments with some respondents expressing an appetite for a deeper level of information for each machine. At present the information contained is aimed at beginner users but the request could be accommodated in future revisions. One respondent expressed the need for collaboration from all woodwork machine training institutes to develop the DLR further as it is exactly what the Irish industry is missing, firmly validating the need for this digital resource.

Conclusions

The use of woodwork machinery can be highly dangerous but with high quality training these dangers can be reduced. GMITL has a proven track record training students in this area but there is always room for improvement. By utilising digital mediums, this project has illustrated how the machine training process can be improved.

The AT strand significantly improves the quality control mechanisms in place to record training progress by utilising GMITL's LMS. LMS have been proven reliable and extremely efficient for administrative duties such as this with testing proving its success.

Considering the DLR test results, it is the most significant development. Research has shown that the GMITL training process lacked visual resources that encouraged active learning to match students learning styles. With the benefits of TEL, the DLR offers an industry leading set of visual resources that will encourage students to actively seek knowledge during their learning process. Testing has proven the demand for this resource and it is hoped the DLR will be of great benefit to GMITL and the broader Irish industry.

Recommendations

The AT and DLR have now been implemented on a trial basis in GMITL since September 2014. A review is planned in the academic year 2015/2016 to examine if these resources have been successful. If proven successful there is an opportunity to move towards a second iteration.

The DLR offers multiple avenues for further work from adding more machines to assessing its long-term benefits. A longitudinal study would need to be devised to assess if students' knowledge retention improves with its use. Consideration should also be given to the impact on pedagogy taking into account the changed learning model.

Other options include the addition of more interactivity, alternate machine visuals and advanced content. One beneficial option would be to collaborate with other training institutes to develop the DLR as an industry standard training resource. What is clear is that this is just the first iteration of many for WWrasp.

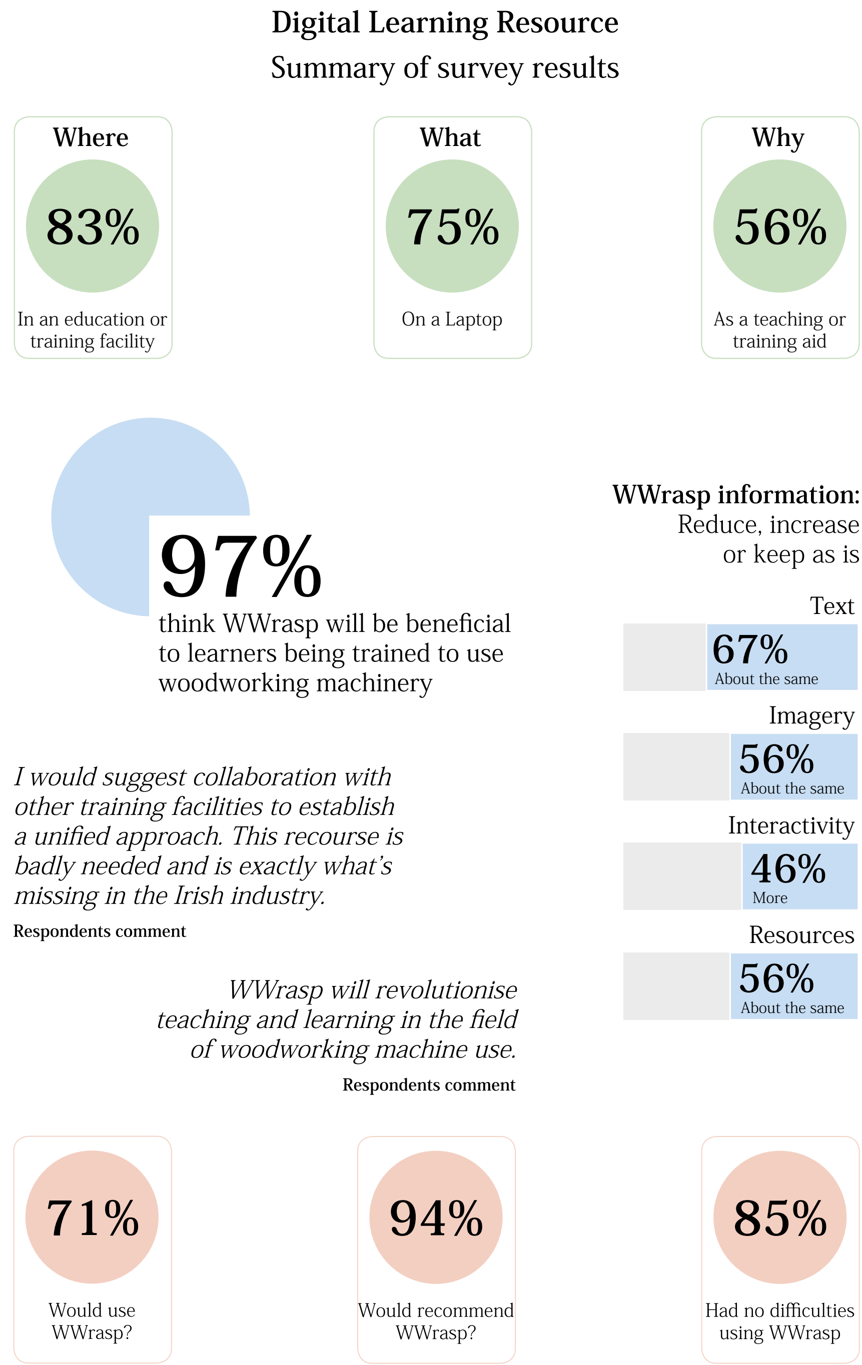

Figure 11