

AN EVALUATION OF THE DESIGN AND USE OF APPLIED VISUAL INTERACTIVE RESOURCES FOR TEACHING BUILDING REGULATIONS IN HIGHER EDUCATION BUILT ENVIRONMENT PROGRAMMES

ABSTRACT

This research is situated in the field of higher education teaching and learning and specifically relates to building regulation pedagogy. A research gap has been identified with scope to develop online visual building regulations for use in higher education built environment programmes, and in parallel, contribute to the teaching and learning research fields of pedagogy, online learning and visual literacy. The aim of this research was to evaluate the design and use of applied visual interactive resources suitable for use in building regulation subjects in higher education built environment programmes. One research question was investigated, namely, whether three examples demonstrating applied visual interactive building regulations were effective and useful in their design. Informed by constructivist theory, an animated video, an interactive learning object and a gamified learning object were profiled as examples within a dedicated research website. Four anonymous survey forms were included on the website to capture feedback. Data received was then evaluated using a single-loop developmental evaluation methodology which informed their systematic redesign during the survey. Survey participants unanimously agreed that applied visual interactive building regulations were effective for online learning. The three examples profiled were acceptable to most survey participants. The research findings conclude that there is significant scope for further research and development of online visual building regulations for higher education built environment programmes.

Keywords: Visual literacy; technology enhanced learning; online learning; building regulation pedagogy; applied visual interactive building regulations

INTRODUCTION

This research is situated in the field of higher education teaching and learning and is relevant to any subject which incorporates building regulations in its educational remit, such as within the disciplines of architecture, architectural technology, engineering and building surveying. Building regulation compliance for design and construction should be an essential training component of all built environment professions. Acts and building regulations have been written and legislated for by governments throughout the developed world as a direct response to societal requirements for consistency, safety and best practice in the built environment. Governments have also published Technical Guidance Documents (TGDs) in Ireland and Approved Documents (ADs) in the United Kingdom to demonstrate how building regulation compliance can be achieved.

Having lectured building regulation compliance for twelve years on an architectural technology undergraduate degree programme in Ireland, the author's opinion as an educator has been informed by this experience (David, 2015). Frequent discussions have been held by the author with architectural technology students in relation to learning, teaching and applying building regulation requirements to project work. International students have indicated that they have time-consuming difficulty translating the TGDs into their native language, after which they are left with little time remaining to apply this to their project work. A similar sentiment has been noted by the Higher Education Academy (2014, p1), where students of a non-English speaking background were found to struggle at first with lectures, tutorials and complex reading tasks. Dyslexic candidates have found the diagrams in the TGDs useful, but have struggled with the extensive written elements. They have voiced their preference for visual learning using pictures, which is reinforced in the literature relating to reading disorders (Heelan, 2015, p2).

This research has been designed within a constructivist theory to explore an additional, rather than exclusive or substitute approach to current building regulation pedagogy, namely an applied visual interactive building regulation (AviBR) approach. To explain further, one could liken the concept of AviBRs to a series of steps or scaffolds which could be used in a staged progression to learn new competencies, transitioning from a place of none or little knowledge of building regulations to one where building compliance requirements for design, contract drawings and building site certification and compliance sign-off are clearly understood and assessed within the confines and safety of an educational setting. Using applied visual interactions, AviBRs could be used as a visual, teaching version of the building regulations in an early-stage educational setting alongside current educational practices or as continuing professional development for those upskilling or refreshing their knowledge whilst working in practice.

RESEARCH CONTEXT

The following section provides a brief overview of the literature relating to current building regulation educational practice and applied visual interactive online learning.

Building regulation pedagogy, literature, digital considerations and site requirements for the built environment in Ireland

Building regulation pedagogy

The depth of knowledge of building regulation requirements varies depending on the discipline. While a Construction Industry Federation (CIF) training programme had claimed to be the only accredited building regulation course in Ireland (CIF, 2017), in reality building regulations have always been embedded in built environment programmes and more extensively so in the field of architectural technology (QQI,

2016) and building surveying (SCSI, 2017). The building regulations can be taught in lectures or applied to project work within built environment higher education programmes using detail design pedagogy in the design studio (Robertson & Emmitt 2016, p16) or in a Computer Aided Design (CAD) or Building Information Modelling (BIM) laboratory. These processes epitomise project-based, hands-on, inquiry-driven learning (Chance et al. 2013, p131).

There are great strides linking pedagogy to practice using BIM, for example, by Mathews (2013) and Kouider et al. (2016). Industry collaboration in the classroom has been documented by Comiskey et al. (2016) and the use of live projects by Harriss (2014) are examples which epitomise the ongoing exemplary practices in higher education built environment programmes. More traditional overarching architectural technology pedagogical papers have been written by Crean and Prunty (2010; 2011), Prunty (2011), Comiskey, Alexander, et al. (2016), and Harty (2016). These studies have not been specifically written about teaching building regulations. The search for literature outlining building regulation pedagogical practice linked directly to building regulation compliance requirements from a design and construction perspective has been less successful. Pacheco et al. (2014) outlined an exercise in legal architecture in Spain, which consisted of lectures, workshops, seminars, group work and a written test combined with a final evaluation, which is commendable teaching and learning research while exemplifying yet another regulation-pedagogy which is more traditional in its approach.

No defining papers or guidance documents were found specifically on building regulation pedagogy. The hope was to find case studies or publications that captured how building regulations can be taught and assessed in higher education built environment programmes. One book was published in 1944 by Neufert, but as it

predates current building regulations, it would not be considered relevant. Therefore, one can conclude that there are opportunities to research and catalogue current building regulation teaching practices across all higher education built environment programmes. This is original research into an area the author has termed applied visual interactive building regulation (AviBR) pedagogy.

Effectiveness of current building regulation curriculum and pedagogy

How effective are educational programmes when it comes to educating students on building regulation requirements? A recent forum post online stated

I am a BA architecture graduate and throughout our course didn't really get educated on building regs. I want to take a course or qualification to develop this knowledge... (looking for) the best (online) route to gaining a good knowledge of building regulations and the laws (Nickwm, 2016).

This is not surprising, given that building regulations are not expressly stated in the Quality and Qualifications Ireland (QQI) document defining the architectural educational award standards (QQI, 2014a). One can conclude that it is not only what is taught and assessed within the built environment higher education programmes but also the transition from graduation to the workplace and professional development up to a competent level which needs to be addressed when adjudicating building regulation pedagogical and competency practices in built environment disciplines.

Similar to the discipline of architecture, building regulations are not expressly stated in the 'Engineering - Award Standards' document published by the QQI (2014b). At present, the profession of building surveying has no award standards currently defined by the QQI. It is interesting to note, then, that all three professions (architecture, engineering and building surveying) are expressly stated as Assigned Certifiers under the Building Control (Amendment) Regulations 2015 in Ireland (Irish Government,

2015), whereas the profession of architectural technology currently is not. There does not appear to be a clear correlation between building regulation training, updates in practice and what happens within an undergraduate programme, nor has account been made of the time from graduation up to a professionally competent level in the workplace, if viewed through the lens of a building regulation educator. An additional question also remains unanswered; are building regulation competencies for design and construction taught and assessed consistently between every discipline?

Generally, after graduation this standard is set, controlled and monitored by professional bodies, such as Engineers Ireland (EI), the Royal Institute of Architects of Ireland (RIAI), the Society of Chartered Surveyors Ireland (SCSI) and the Chartered Institute of Architectural Technologists (CIAT), to name a few. One can conclude from this that building regulation educators in the built environment should foment continuing professional development practices from graduation on in consultation with all professional bodies together and key stakeholders to inform educational upskilling requirements stemming from regulation updates or changes, while addressing building regulation requirements in educational standards at a national level in these specific disciplines in Ireland.

A commendable example of how post-graduate training has been realised is the near Zero Energy Building (nZEB) training programme which was pioneered by Dublin Institute of Technology (DIT) (McGuinness, 2017). The remit was to upskill professionals ahead of the publication of a new version of TGD L 'Conservation of Energy' (DoHPCLG, 2017d) which had gone through a public consultation phase in Ireland in May 2017. A national framework of initiatives such as this should be further investigated by higher education building regulation educators to address shortfalls in building regulation education and upskilling in new building regulations and to

adjudicate unquestionable transparency and rigour in all processes relating to proving an unequivocal building regulation compliance base from design to construction in consultation with all professionals and key stakeholders in these fields.

TGDs / ADs and building regulation literature

TGDs in the Republic of Ireland are freely available as downloadable Portable Document Format (PDF) files from the Irish government's website. Students are in a difficult position, particularly the first time they are introduced to TGDs. They need to familiarise themselves with these documents, which is a daunting task of 1,010 pages for Part A to M inclusively (DoHPCLG, 2004, 2006, 2014c, 2016a, 2017d, 2017b, 2008, 2009, 2010b, 2011, 2012, 2013, 2014a, 2014b). For example, to complete a fire safety certificate application, depending on the purpose group of the building, it may require a student to refer to Part B plus additional British Standard (BS) documents (British Standards, 2017), Building Bulletins (BB) (Bissell *et al.*, 2007) and Building Research Establishment (BRE) publications (Chitty, 2014). These documents are referred to within the TGDs and can therefore be interpreted as being bound by the same compliance rigour.

To prove compliance with TGD L or Part L, 'Conservation of Energy', for example, Part F, J, L and the supplementary documents need to be familiar to design a dwelling, amounting to 462 pages (DoHPCLG, 2008, 2009, 2014a, 2016b, 2017d). These need to be read in conjunction with a Dwelling Energy Assessment Procedure (DEAP) assessment to calculate a Building Energy Rating (BER). Incidentally, the documents required to be accessed for this assessment amount to an additional 1,000 pages approximately and require the use of a software package and an excel spreadsheet, both of which are freely downloadable from the Sustainable Energy Authority of Ireland's (SEAI's) website. Having to refer to overlapping TGDs and

additional documentation when designing a building for the first time can be challenging. An example of this would be the design and specification of glazing. This would require a student in Ireland to refer to Part B (DoHPCLG, 2006, 2017b), Part K (DoHPCLG, 2014c), Part D (DoHPCLG, 2013), Part M (DoHPCLG, 2010c), Part F (DoHPCLG, 2009) and Part L (DoHPCLG, 2017c, 2017a). This compares to the United Kingdom's building regulations, which also include an additional Part N, 'Approved Document N – Glazing – Safety in relation to impact, opening and cleaning' (HM Government, 2013). The Irish Health and Safety Authority's (HSA) Safe System of Work Plan (SSWP) communicates visually used pictograms and has been successfully implemented to enhance communication of site safety (HSA, 2014). Taking the lead from initiatives such as this, the precedent exists to follow suit with a visual application of building regulations within an educational remit.

Technology used for building regulation education

A search for dedicated web-based teaching resources for building regulations identified that no open-access resources exist. A few useful websites do exist, however, they appear to be blogs for professionals (Murray *et al.*, 2017) or else wiki sites (Designing Buildings Ltd., no date). No dedicated building regulation teaching resource was found in searches, although the Chartered Association of Building Engineers (CABE) have useful You Tube videos online which are relevant in the United Kingdom (CABE, 2016) and in the Republic of Ireland, EI have an extensive webcast archive available online. A search was conducted on Apple internet Operating Systems (iOS) and android platforms for applications relating to building regulations and appropriate teaching resources. Two applications were available which contain information relating to Irish building regulations, namely 'The Building Regulations IE' and 'BuildRegsIreland' (Designdirekt Ltd, 2015). On inspection, however, they were found to be simply

repositories that regurgitate the TGDs while not offering engaging learning in their design. The second application, which was subscription-only, did illustrate TGD clauses hyperlinked to visual representations of buildings, but as such was not a teaching resource, and it quoted regulations line-by-line, rather than implementing further visual teaching, learning and assessment techniques.

Gaming techniques have been used for health and safety construction site training for a few years. These were pioneered by Teesside University (Dawood *et al.*, 2013) but are not freely available resources. This software makes learning site safety believable, with various scenarios of what could go wrong on a building site played, learning how to avoid them without putting oneself in danger on a real building site. This technique would be useful alongside other techniques to teach building regulations. Game based learning provides a mode through which creative and independent learning can be achieved (Ryan 2014, p4). The demonstration of applied knowledge and understanding happens concurrently within the action and environment of a game, thus empowering a student centred learning approach (Foucault 1975; Carlile & Jordan 2005, p23). This has informed the primary research design of example 3. When searching for Technology Enhanced Learning (TEL) examples in order to teach building regulations, Comiskey *et al.*'s (2013) paper describing the use of an ibook in architectural technology classes is to be commended. A suggestion could be to develop it further with interactive and gamified elements to greatly enhance the usefulness of the reusable learning object. If it were designed to meet the remit of an AviBR, for example, it would need to be written with learning, teaching, assessment and evaluation pedagogy embedded into the building regulation elements, in an applied, interactive, visual manner.

Linking educational practices to site requirements

One could argue that there is a distinct gap between educational practices and industry requirements in the context of building regulations until one's experience and education reinforce each other once working in practice. One instrument which can bridge this gap is the BIM process, which is being used in some contracts to lend rigour, transparency and validity to building regulation checks, compliance requirements and sign-off. Can this be extended into education? With the construction industry in the United Kingdom at BIM level 2 (Mellon and Kouider, 2016), it is early in its process evolution. It is still to be adopted in some countries, including Ireland, with the exception of new government contracts (McAuley et al. 2017, p6). When routines and scheduling are applied in one dedicated level 3 BIM model, wholesale building regulation compliance checks will be fully realised and a dynamic shift of power to practitioners performing this functionality will become even more evident. Changes to building regulation compliance practices will need to be fed in tandem into academia. This will be extremely useful in the context of teaching building regulations to architectural technology students and may help to improve their learning.

Visual applied interactive learning

Visual literacy skill used for learning, multi-sensory learning, multimodal learning

When researching visual learning, the literature available was found to be diverse and plentiful, and included multimedia learning, multiple representations learning and multimodality. Concept mapping (Magna Publications, 2011) and a knowledge of a visual learning spectrum (Moore and Dwyer, 1994) would be useful when designing AviBRs. Hill (1990) describes activities with pictures used to spark language learning. This

strategy would be a useful if applied to building regulation pedagogy. Mange et al. (2015) alluded to the fact that visual learning is a learning preference of many architectural students. This assumes an underlying visual literacy skill. However, it is not an exclusive learning preference.

Architects are visual learners... Show me how to do something and I have got it. Tell me how and I am shaky on it. Make me read a manual and I will fall asleep before I finish (although) nothing replaces being taught directly from a human being standing in your presence (Calisti, 2011).

Apart from a visual learning preference, what this architect is also describing is experiential learning using a multi-sensory approach to learning. The visual learning can be met by using drawings and models. The tactile learning can come from the touch of paper, cardboard models, models made with different textured materials, writing implements and computers. Whereas the sound of a person's voice meets an aural learning need and the social interactions in a studio setting, peer-to-peer learning and learning by demonstration would fulfil the social-aspect for a holistic multi-sensory approach to learning. One can copy-by-doing in an experiential model using multi-sensory approaches to learning in a design studio setting. The author would suggest that the architect's preferred learning style might be labelled as kinaesthetic, preferring project-based learning, solving problems by trial and error in a hands-on, applied way (Friedman, 2013, p12), which epitomises studio-based practice. This principle could also inform the design of online learning artefacts and would require further research in the context of AviBR design. The fact that a visual learning preference cannot be used in isolation also rings true from the findings of Mange, Adane and Nafde (2015, p210), stating that aural and visual teaching techniques will help architectural students to concentrate for longer rather than simply by using visuals alone. Using multimodality methods such as the combination of video, audio and animations can enhance

immersive learning (Articulate, 2015). The form, medium and mode (Bezemer, 2012) of AviBRs will need to be examined closely while noting the inherent multimodal literacy and skills of learners (Lim, 2011).

Universal design for learning

Learners and educators require positive relationships and interactions (Hagenauer & Volet 2014, p371). The learner should have an equivalent experience with the material they are being taught. Students with dyslexia have reported an improved learning experience if they can conduct experiments, watch You Tube videos or listen to audio books in lieu of reading new learning material alone (Heelan 2015, p2). In other words, a visual, reduced-language, applied, multi-sensory approach to learning. Would a passive video be suitable for use as an AviBR? This has informed the design of primary research example 1.

The integration of Universal Design for Learning (UDL) techniques can further enhance and inform AviBR design, which will be inclusive for more learners (Alberta Education, 2015) while being easier to follow by incorporating a staged, scaffolded approach. The clarity of formulating a concrete beginning, middle and end to a building regulation lesson plan using UDL principles (Cabaj 2009; Patton 2011, p9) is preferable to making reference to multiple TGDs or ADs which might typically be required in design studio practice. The AviBR reusable learning objects' design could capture specific scaffolds used either in the classroom, as blended or online learning, taught in the spirit of constructivist learning, where students could engage in the AviBR material for a short time and the lecturer could intervene or interpret if required (Donnelly, 2016). The author still holds firm that ideally this must be delivered in the context of project-based learning and be directly relevant to a specific project for this process to be successful. If it is delivered wholly online, then it would require the lecturer to suggest

this be done in parallel to a live project, or for more comprehensive courses, to enforce this as a mandatory online learning requirement. Gilly Salmon's (2013) five-stage model of e-learning is one such model which could be followed for online learning. This, however, falls outside of the scope of this research.

Building regulation semiotics

Semiotics specifically for the built environment are standard practice but may vary slightly between disciplines and countries. Therefore, AviBR design should embed a building regulation semiotic standard for cohesiveness (Heimans, 2011, p385) to facilitate dialogue between multidisciplinary learners from different countries with a variety of languages. This is essential for meaningful communication of drawing and documentation requirements and capturing site compliance requirements, for example. This could call for the standardisation of a building regulation compliance etiquette as a sub-branch of building regulation semiotics in the context of a BIM contract, for example. As an educational example, for an AviBR outlining a stair design, it would need to visually state its semiotic assumptions before outlining building regulation compliance requirements. There is scope for further research to holistically define building regulation semiotics outside of current published standards. If AviBR design is approached with a semiotic lens it could, in theory, standardise and unify the understanding and communication of building regulation compliance requirements across a variety of disciplines, countries and languages.

Applied, experiential learning and interactive learning

Kolb's experiential learning cycle (Kolb and Fry, 1975; Kolb, 1984) demonstrates a simple experiential learning model. This has been overlaid with learning styles by Chance et al. (2013, p135; Sheehan & Kearns 1995), concluding that even Kolb found

that students from engineering and architecture disciplines, among others, learn and make decisions differently. In other words, their tendencies towards experiential learning are heightened in an applied context. Race (2011) argued that it was our duty as educators to create opportunities for learning as it might not necessarily happen otherwise. This has informed the design of the primary research example 2 and 3. Can an interactive image aid building regulation learning and understanding when integrated into a bespoke learning object design? If one were to use an interactive learning object, the cause-and-affect nature of the design completed using visuals with touch-screen animation, or touch-screen photo-realistic images, for example, the author would suspect that this may make learning even more effective.

Similarly, three dimensional environments using BIM 360 or fully-immersive environments using gaming software such as 'Unity' or a gaming platform such as 'Steam' could equally be explored in the context of AviBR design. Literature searches for this type of approach yielded limited results and fell outside of the scope of this research. While searches for applied learning and interactive learning yielded results from Kolb, constructivist theories, and student centred learning (Lea, Stephenson and Troy, 2003), the strategies for social interactive learning conducted in the classroom could only be sourced from videos created by the University of Texas in Austin (2017). These resources were reported to be easy to follow and suggest good examples of how to get students to engage in teaching material and interact with each other in their learning environment. Similarly, applied visual learning and applied visual interactive learning did not yield conclusive results, both in general and in the context of building regulation education. Wolfe (2005) outlines teaching practices to customise the curriculum which include some of the teaching techniques of applied visual learning

and applied visual interactive learning, although what that author was actually describing was a UDL approach.

Literature analysis conclusion

The literature review has identified that further research and development is required in the areas of teaching and learning building regulations online, and the design of applied visual interactive reusable learning resources may be instrumental in fulfilling this remit. The fact that building regulations are best learned in an applied, contextualised manner, stemming from knowledge gained from design studio practice (David, 2015), should inform the design of AviBRs. Similarly, that visual, multimodal learning is preferable, but not exclusive, should equally inform their design. These findings have influenced the design of all three primary research examples 1, 2 and 3.

To conclude, this review has identified a research gap in the areas of visual building regulation pedagogy and building regulation online learning tools suitable for use in built environment higher education programmes; while in parallel, in the context of higher education teaching and learning, the findings may also contribute new knowledge to the fields of pedagogy, online learning and visual literacy.

AIM AND RESEARCH QUESTION

The aim of this research was to evaluate the design and use of applied visual interactive resources suitable for teaching building regulation subjects in higher education built environment programmes, with a focus on Ireland. One research question was investigated, namely, to ascertain if three examples of applied visual interactive building regulations were effective and useful in their design? How did relevant stakeholders evaluate these examples in relation to the choice of learning medium (e.g. video) and form (e.g. animation)?

METHOD

This research has been conducted as a developmental evaluation from a utilization-focused perspective, which allowed the author to test and quickly respond to feedback received with appropriate changes to examples 1, 2 and 3 (Patton, 2011, p14).

Developmental evaluation sits within the overarching 'utilisation-focused evaluation', which is an evaluative process that is completed for a specific purpose and for intended users (Patton 2011, p7, 13).

The author aligned the research approach with a constructivist ontological lens (Bryman, 2012, p33), recognising that the regulations and their interpretation are always being tested, revised or updated to some extent. This research used an epistemological basis of interpretivism because the research findings were the result of trialing primary research examples 1, 2 and 3, as opposed to imitating or repeating an aspect of the building regulations (Kroll & LaBosky, 1996; UCD, n.d.). In the context of this research, developmental evaluation became an aid to the design and development of this innovation (Mathison 2005, p115; Patton 2011, p20). As this research evolved, so too did the design and development of the three primary research examples (Patton 2011, p5), within a constructionist paradigm of learning-by-doing.

To generalise findings from this research, the first three survey questions for each example were quantitative in nature, using a Likert scale for the third question. The fourth question was qualitative, seeking to validate findings through multiple methods of data collection (Onwuegbuzie & Johnson 2006 p57; Cohen et al. 2011 p198). The two different lenses of positivism and interpretive paradigms resulting from mixed-mode findings (Cohen et al. 2011, p31) was resolved by adopting a pragmatism paradigm to address this conflict (Creswell 2007, pp10, 14-15) while being respectful of the merits of both (Greene et al. 1989; Creswell 2007, p15). The survey questions were

designed to triangulate findings from a variety of key stakeholders (Felder & Brent 1994, pG-2) to either validate or invalidate research findings as part of an effective evaluation for knowledge.

The developmental evaluation was conducted using a single loop developmental evaluation process (Bornstein, 2007; Patton, 2011, p11) with feedback from survey questions reviewed on an on-going basis to seek a deeper appreciation and faster change-iteration of the three primary research examples (Chelimskey, 1997; Saunders, 2006, p205). This approach was in keeping with a constructivist theory of learning, where active learning is linked to constructed knowledge in the context of this research remit (UCD, no date).

Tools and survey design

Three examples of AviBRs were delivered asynchronously within a dedicated research website created using Weebly, at <http://avibr.weebly.com/>. The website was not searchable online. The freeware functionality within Weebly allowed only four questions per questionnaire. As a result, the author did not ask age, sex, ethnicity, discipline or disability but instead focussed on the examples themselves. Such information could have been perceived as discriminatory if the research were subsequently seen to give greater validity to one group's opinion in comparison to another. It was felt that it would be unethical to do so.

The survey questions related back to the research question and overall aim of the research. Four survey questions were included in each of the four pages on the research website. Participants were requested to provide feedback on the three examples before providing feedback on the first webpage, which sought further information in relation to the use of AviBRs in education.



Figure 1. Example 1. An animated video indicating disabled refuge requirements

Example 1 was an animated video. It was posted on You Tube and created using a stop motion application on an i-pad mini. All illustrations were drawn using pro-markers and tech-liners. A screenshot of the page can be seen in Figure 1.

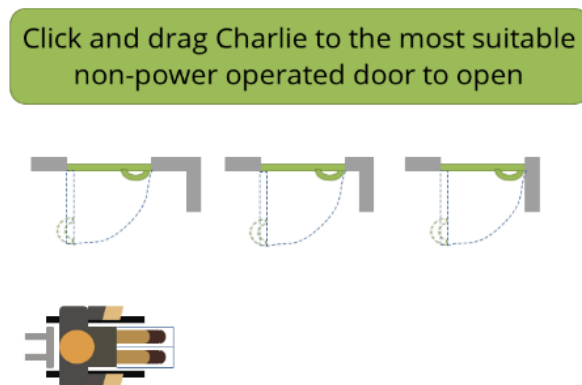


Figure 2. Example 2. An interactive learning object indicating a leading edge requirement

All computer and web applications used for the purposes of this research were freely available. Example 2 and 3 were created using a thirty-day free trial of Articulate Storyline 2. This software was chosen as it allowed the author to create interactive visual images relatively easily. Figure 2 illustrates screenshots from example 2 which

was intended to demonstrate an interactive learning object representing TGD M 'Access and Use' (DoHPCLG, 2010a) leading edge requirements of a door.



Click on the image to start an interactive and gamified learning object - cavity barriers used in construction.

Figure 3. Example 3. An interactive and gamified learning object indicating cavity barrier requirements

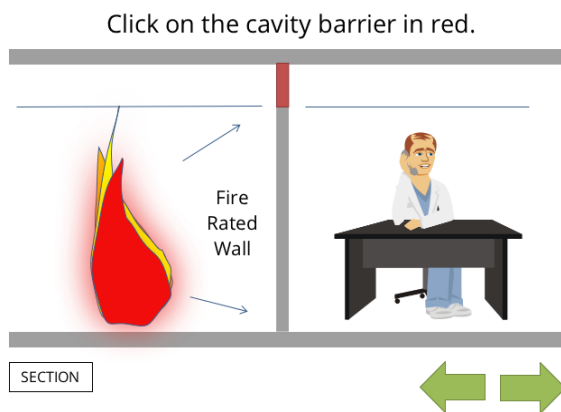


Figure 4. Example 3. An interactive learning object indicating cavity barrier requirements



Figure 5. Example 3. A gamified learning object assessing cavity barrier requirements to see how one scores

Example 3 involved indicating cavity barrier requirements for TGD B ‘Fire Safety’ (DoHPCLG, 2006) within a gamified learning object. Screenshots from this web page can be seen in Figure 3, 4 and 5.

Participants

The survey was sent by email to staff and students in the Department of Building and Civil Engineering at Galway-Mayo Institute of Technology (GMIT), where the disciplines of civil engineering, architectural technology, quantity surveying and construction management are taught. It was then circulated on LinkedIn and Twitter and emailed to industry and educational contacts. The survey was circulated by the CIAT to its members internationally via an electronic newsletter (CIAT, 2017). Feedback was requested from any country and from practitioners, educators, lecturers, tutors, researchers and students alike. Space triangulation was used to gain feedback from more than one discipline or country (Cohen et al. 2011, p196).

Methods used for data analysis

The responses received from four survey questionnaires were downloaded into an excel

spreadsheet directly from the Weebly website. One spam entry was omitted along with two duplicate entries. All remaining entries were considered genuine with unique, verifiable Internet Protocol (IP) addresses. The data was colour-coded into three classifications: positive feedback, suggestions for improvement and negative feedback. Answers were coded line by line thus facilitating easier understanding and extrapolation of findings. The two latter classifications were acted on immediately as part of the developmental evaluation. Fifteen themes emerged from the remaining qualitative findings, which were teased out using a powerpoint presentation and bullet points to interpret and group together similar and opposing opinions on various aspects of the primary research.

Ethics

Permission to refer to the Irish building regulations was received from the Irish government by e-mail. A disclaimer was added to the research website to explain that the three examples were not a substitute for the legally binding building regulations and that they were based on the Irish building regulations alone. Ethical clearance was obtained for this research and findings were kept anonymous with informed consent. A consent form and a participant information sheet were directly downloadable from the research website.

Scope and limitations

This research has excluded other types of TEL and Web 2.0 tools, quizzes, document uploads, screen-recordings, 3D prints, 3D visualisations, augmented reality, virtual reality, any assessment and evaluation practices, as well as laboratory, physical or electronic experiential learning options for AviBRs, to name a few. A further limitation of this research is that only Irish building regulations and legislation is referred to. A

final limitation is that a broader scaffolded curriculum design and online pedagogical approach has not been included at this time and may be considered in future research.

ANALYSIS OF RESEARCH FINDINGS AND REFLECTION

The research findings are presented below and discussed in a reflective manner, first in relation to the quantitative data and then in relation to the qualitative comments received from respondents.

Quantitative research findings

The survey was responded to by participants from England, Wales, Northern Ireland and the Republic of Ireland.

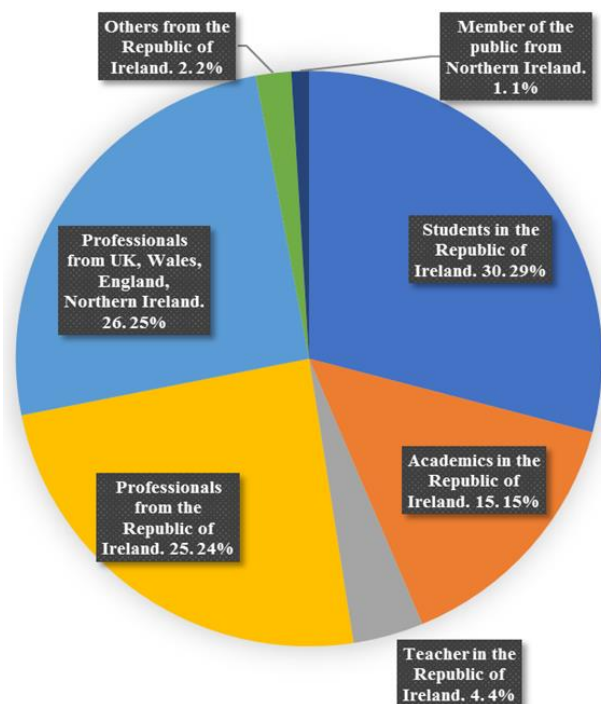


Figure 6. Spread of survey participants

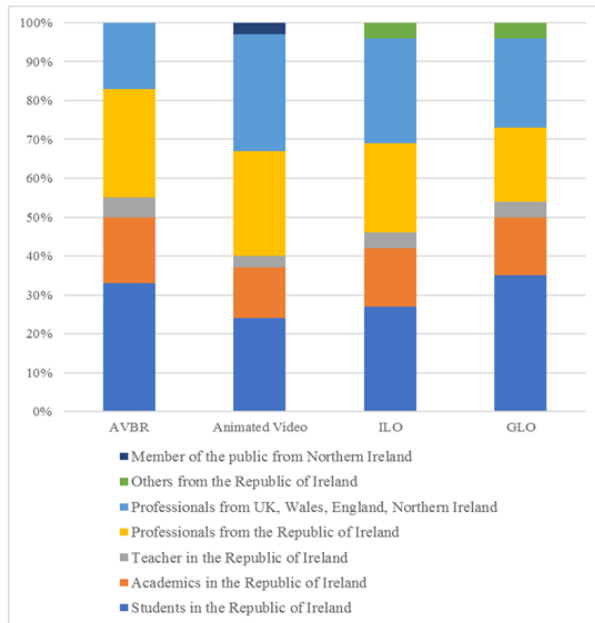


Figure 7. Range of survey participants per questionnaire, 1 to 4 indicated left to right

103 valid entries were received and represented approximately 50% professional and 50% academic, teacher or student, as illustrated in Figure 6 and 7. This presented findings from a balanced range of key stakeholders and included a variety of countries. Single-loop design changes that were completed during the developmental evaluation process have not been published in this research but have been retained by the author. Single-loop modifications (Patton 2011, p11) of examples 1, 2 and 3, based on instantaneous participant feedback, facilitated a deeper evolutionary design process beyond surface learning towards a greater understanding of the AviBR's performance and intended purpose.

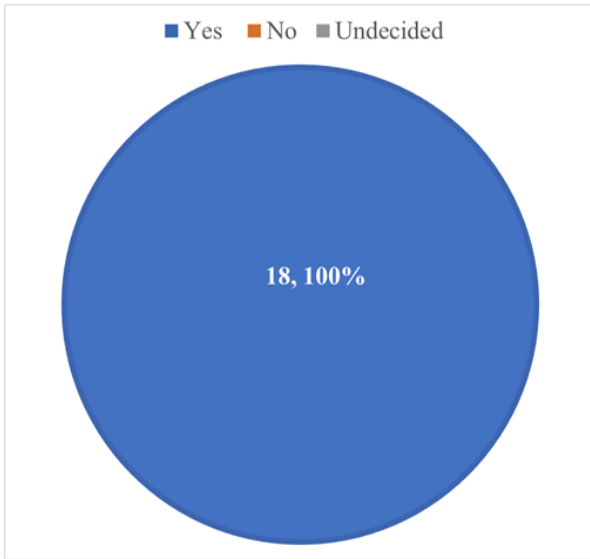


Figure 8. Survey responses: Do you think Avibrs can be effective as e-learning tools in education?

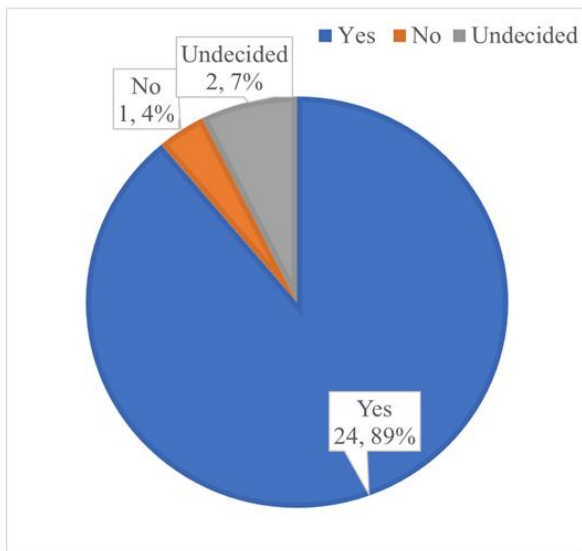


Figure 9. Survey responses: This is an example of an animated video. Do you think it can be effective as an e-learning tool?

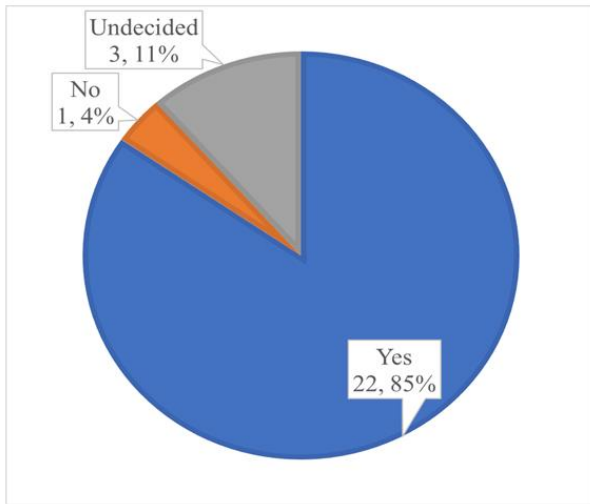


Figure 10. Survey responses: This is an example of an interactive learning object. Do you think it can be effective as an e-learning tool?

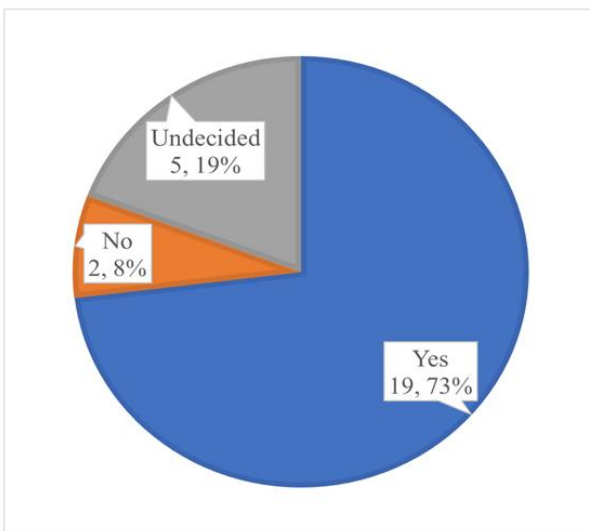


Figure 11. Survey responses: This is an example of a gamified learning object. Do you think it can be effective as an e-learning tool?

Feedback was generally positive in relation to the design and use of AviBRs as an educational e-learning tool, as illustrated in Figures 8, 9, 10 and 11. 100% were in favour of AviBRs as effective e-learning tools in education with 89% in favour of the animated video example, 85% in favour of the interactive learning example and 73% in favour of the gamified learning example. The animated video received the largest

number of comments. It could be presumed that this was because it was the first example on the research website. Also, it contained a large amount of technical content, it was the least likely to have a technical glitch, it was an example which could be viewed by simply pressing play and it could be viewed and replayed on You Tube which is a familiar platform to many.

Qualitative research findings

Themes questioning relevance or noting limited relevance e.g. it is useful for students with dyslexia and varying abilities; it can reduce translation issues

Outside of the single-loop developmental evaluation feedback and corrections, nearly all research participants commented favourably, except one, who commented that ‘the approved documents are so clear that this exercise is irrelevant’. This was the first theme found in the research, questioning its relevance. The second theme that emerged was that it was useful for students with dyslexia and varying abilities. For example, one of the respondents commented that ‘as a person with dyslexia, I find this video would have great benefits for someone with reading difficulties, in helping them understand the TGD's’. Another agreed, noting that ‘yes, it is effective as visualisation can help to explain especially for people with varying abilities’. The third theme noted was that it could be useful to reduce translation issues, noting that ‘it would be very beneficial to foreigners working in Ireland who have poor English’.

It can encompass UDL requirements; it can reduce excessive reading requirements

Another emerging theme was that it could encompass UDL requirements. A respondent commented that ‘for people with different learning preferences I feel it’s important to deliver the information in a variety of ways. This is my preferred way of learning and if

the same information had been presented in a separate way e.g. all written down, I would probably not have understood it at all clearly'. Another stated that 'they proved a different perspective from reading books and journals'. In other words, the concept of AviBRs may offer an alternative to current teaching practices to meet UDL requirements. This warrants further research.

A few responses alluded to a fifth theme, suggesting that the use of AviBRs could reduce the excessive reading requirements of building regulations in an educational context. One participant reported that 'regulations aren't necessarily suited to everyone, they are suitable for those who can take in lots of information reading tedious amount of text. For people who get lost in text like myself, visual, interactive aids help'. Another noted that 'sometimes a visual representation of the regulation is easier to understand than reading the regulations', while two further responses received stated 'it's easier to watch something than to read!' and that 'visual aids always help in digesting the information'. These findings mirror the authors' own observations as a building regulation educator, in that a visual, reduced-language form of building regulations can be useful for many in an educational context, for a variety of reasons.

Visual literacy is beneficial; visual aids are appropriate

A significant number of responses were noted in the sixth theme confirming that, for some, visual literacy is beneficial to learning in this context. One comment received was that the building regulations were 'very easy to understand with images' while another noted that AviBRs 'will benefit people with a visual learning style'; a further comment was that it was 'effective for a visual learner which I consider myself to be'; similar opinion was voiced by an additional three respondents, stating that 'they are great especially for visual learners', that AviBRs were 'easy to visualise' and that the AviBRs were 'great, easy to remember, visual'. A supplementary comment received suggested

that ‘for me, the best way to learn is to create an image in my mind, so this is useful’.

The author can conclude from the corroboration and validity of these findings that there is scope to explore in-depth visual literacy within learning objects, the design, mode and medium choices and to consider multi-modality and building regulation semiotics in further research.

The seventh theme found was that the visual aids were considered appropriate. One quotation from the data collected was that ‘visual aids always give a clearer insight to understanding concepts behind subject learning’. Agreeing with this, another respondent reported that the AviBRs were ‘excellent visual material that effectively communicate the required information and core concepts’. However, the author did not consider a visual approach sufficient in isolation to meet the required teaching remit for building regulation pedagogy. All three examples were directly relevant to the building regulations, in other words, they were active or applied learning examples (Kolb, 1984).

Interactive aids are appropriate; interaction is useful

The eighth theme emerged from research findings was that the interactive aids were also considered appropriate. A participant alluded to this by stating that the interactive AviBRs were ‘very effective at bringing theory into practice’. Many other favourable comments on the appropriateness of the interactive building regulation examples were received, such as ‘I think this is an effective e-learning tool as it helps students to greatly understand the key aspects of the Irish Building Regulations’. A further comment received suggested that the AviBR was ‘interactive and “forces” the participant to engage and think about the learning presented previously. Provides a clear question and clear answers - no ambiguity. Reinforces and ensures understanding of the objective before concluding’. The author can surmise from this that the order and sequence of information within the AviBR is as important as the interactive elements

themselves. Similarly, how the learner is lead through their learning journey within each AviBR's design needs to be considered. The beginning, middle and end of the design of AviBRs along with clear communication pathways and signposting will need to be considered in further research.

The ninth theme found was that the interactions were useful. One such comment was that 'interaction as a mode of learning requires the participant to engage in active learning and draw on existing knowledge or recently learned'. Another participant noted that 'it involves the learner in a more dynamic way', while a further considered that 'the speed of the interactions keeps the content engaging allowing associations to be made and making the learning experience fun'. It was reported that 'it is satisfying when your interaction asks and gives the immediate feedback of the answer to the learner, this is very effective. Very good interaction overall'. An additional participant commented that 'interactive learning is fun, engaging', with supplementary feedback from another respondent noting that 'it's interactive which adds to and aids learning'.

Interaction is better than video; interaction is better than reading

In contrast between passive and active learning, or in this case, to compare video to interaction in an AviBRs design, a tenth theme emerged. The findings strongly suggest that interaction is better than video. One participant commented that 'having to engage physically to manipulate the images to get the correct answer is more gratifying than just watching a video showing the same thing'. Another considered that 'it is definitely more engaging than watching a video' and an additional participant agreed with this, declaring that the interaction 'engages the student, requires them to think rather than just try to absorb information'. Supplementary feedback included 'personally I found examples two and three better than example one. This is down to the interactive elements which I believe will hold peoples' attention better than a video'. To conclude,

there is an argument to further explore the interrelationship between video and interactive learning objects and their most appropriate application, to try to understand this issue further. However, this finding is in keeping with the literature analysis findings, which also favoured active, experiential learning.

An eleventh theme suggests that interactions are better than reading in the context of learning building regulations. In comparison to current educational practices, one participant noted that ‘interactive learning engages the brain and requires the student to apply knowledge on an ongoing basis - large chunks of written or spoken material delivered over a two, three or four-hour period is not an effective learning tool as the brain is not capable of engaging and focus for extended periods lest retain the information’. In other words, the concept of AviBRs may be more suitable than some current pedagogical practices or offer an alternative or be used in tandem with current practices. This warrants further research.

Games are also useful

The twelfth theme was significant in that gamified learning was found to be useful in the context of visual building regulation pedagogy. Fruitful feedback was received, such as from a respondent who commented that ‘there is a trial by error aspect to example 3 which also aids memory in recall’. Another noted that ‘you have to put some thought into your selected solution, but if you choose incorrectly you will eventually figure out the right answer which you are more likely to retain in your memory’. A further respondent reported that ‘this is effective in communicating the core concepts of the specific issue. It is also interesting as it allows the user to test the spatial constraints themselves via a scaled representation. Very interesting and informative’. An additional comment was that ‘the game-based mechanic might be motivational, especially if linked to a scoring system. That might drive competition within a class group and motivate

some students to try harder'. A supplementary comment stated that 'the quiz will ensure the participants are paying attention as they have to pass to proceed'. Gamified resources are intuitively interactive, so to conclude, gamified or motivational teaching, learning and assessment resources would be suitable for consideration in further research when designing AviBRs within a visual building regulation pedagogy.

Considerations for improvement

The design of the three examples require further reflection and redesign. Caution and varied opinions were found in participant feedback, which leads to the penultimate theme drawn from this research, in that there are considerations for improvement. One participant stated that AviBRs 'can generally convey the concept of the subject learning quickly and effectively, provided that the visuals and right/wrong methods are shown to enable comparison'. Similarly, another reported that it 'could be effective but needs more explanation of the correct answers and why this is correct or incorrect!' Again, relating to the design of the examples, a further respondent stated that 'I think the way the information is presented is critical and there's a fine balance between the visual images, text and voice over commentary'. The mode (e.g. video) and medium (e.g. animation) choices in example 1 had opinion divided, with one participant reporting that 'it was a very informative presentation and the simplicity of the hand-drawn/hand-written notes added to the direct yet simple way of delivering the information. The animation was fun to watch, and made a refreshing change to computer generated animations', whereas another stated that 'they are a bit unprofessional by comparison to some of the videos that are available online. However, they do convey the information effectively' and an additional participant stated 'I think something edgier and snappier may be required to get through the extent of the building regulations'. A supplementary comment reported was that 'I would suggest a voice recording to ask the questions and

to give feedback. It would make it feel more interactive. Maybe adding sound effects would also help. Typing the text would look better than handwriting in the first example' whereas a different respondent suggested to 'keep writing to a minimum' altogether. Two further participants reported that the video was fast, whereas a different two considered it too slow. Subsequent feedback suggested that one respondent would like to see more content added, reporting the gamified example 'would be more effective with some video demonstrations of how fire will travel within a building'. To conclude, there is more in-depth analysis on the design of the AviBRs yet to be conducted in further research.

Varied applications for AviBRs and visual building regulation pedagogy

From the perspective of survey participants, there was varied opinion as to the application or use of AviBRs. This leads to the fourteenth theme, in that it's application can be varied. For example, one respondent considered that the approach could be 'beneficial for students, year one or two undergrad, as it is easy for the student to understand the information, and it explains the reason for the specific regulation'. Similarly, another reported that 'these visuals would be perfect in a classroom environment while the teacher or lecturer are explaining the regulations' and a further commented that the pilot was a 'perfect example of how the regulations can be taught to accompany large text documents'. In other words, the concept of AviBRs would be very suited within an educational setting alongside current pedagogical practices. However, feedback from an additional participant considered AviBRs to be suitable for use in a different context, reporting that 'this could also be used in the professional environment, perhaps for continuing professional development'. A similar idea was received, suggesting the creation of 'a nice test. Like the National Car Test (NCT) theory test for building regulations. A full program like that can be clicked as this example. This will

be retained in memory'. A different participant suggested that the 'tool could be used to convey reasons to clients as well through screenshots etc'. An additional comment received was that 'you could design it as interactive aids to accompany the regulations, be it an app that highlights the "new" codes and regulations. This is the future.' One reported that 'the tool can be controlled and managed by me from a stop, start, replay point of view. Accessibility of e-learning tools by their nature allow anytime anywhere learning'. Another option suggested was that 'in a world where people are using phones, tablets, etc. to find information', that AviBRs would make a positive contribution in educational fields. A supplementary comment received noted that 'it allows you to try and think back on stuff you have done before to see if you still remember them' while a subsequent respondent stated that it 'gives great information ... and lets you interact allowing you to see how much you know', both comments appearing to allude to prior knowledge and the possibility of continuing professional development training and revision. This warrants further research.

Understanding and reasoning behind technical content important

The fifteenth and final theme to emerge is that understanding the reasoning behind building regulation requirements is an important aspect to consider in an AviBR's design. One unexpected outcome from the survey findings was that the reasoning behind some building regulations may not be fully understood. The author is of the opinion that an intuitive understanding of why any aspect of a building regulation is required is essential to remember for ones' design work. A respondent stated 'now I understand why a leading edge is needed whereas with the current way the information is delivered – as with other section of the ADs the reasons aren't obvious or set out meaning you don't understand the whys of the requirements'. Another respondent also commented that 'I think this video will help students understand why it's necessary to

have these regulations in place'. This should be used to inform AviBR design choices wherever possible.

Research analysis conclusion

The conclusion is that AviBRs, in an educational context and used within an applied interactive visual building regulation pedagogical framework, could be useful, both in the classroom alongside current building regulation pedagogical practices as well as within professional upskilling courses and continuing professional development programmes.

CONCLUSION

Given the findings from the literature review and the questionnaire it can be concluded that there is significant scope for a new visual applied interactive approach to building regulation educational practice. Reflection on the research findings would also suggest that this should be an online, applied, interactive, visual building regulation pedagogical approach. AviBRs can substitute the technical language in some TGDs with project-rich, visual case studies and interactive, applied, visual examples. This can be designed within an online, scaffolded approach based on UDL principles.

The design of AviBR teaching tools will require significant emphasis on medium and form, acknowledging multimodal literacy and appropriate building regulation semiotic techniques. The design also needs to make consideration for further pedagogical and supportive educational theory choices, software and hardware options, mode of delivery and scaffolded discipline-specific curriculum design. If there are activities which can be completed online, it would be advantageous to embed learning, teaching, assessment and evaluation processes into the design of the visual building

regulation pedagogy. The way this may be achieved will, most likely, vary depending on the programme of study and the specific needs of the teachers and learners.

The intention is that further ongoing research into AviBRs beyond this research will continue to contribute new knowledge to the field of applied visual interactive building regulation pedagogy for built environment higher education programmes. It will further develop relevant educational literature and teaching tools and in parallel, continue to contribute to the field of higher education pedagogy, online learning and visual literacy.

The extremely challenging requirements of building regulation compliance places responsibility on built environment professionals to ensure that peoples' safety is paramount. One could argue that through this lens, the link between education and practice is neither direct enough nor clear enough. Explicit traceability and accountability for building regulation compliance in and between the three progressive areas of undergraduate education, transitioning to work and professional working life will continue to be challenging from a design and construction viewpoint. This, no doubt, will eventually be achieved in parallel or integrated within a BIM environment. If AviBRs are used in education as either teaching tools or within an overarching online visual building regulation pedagogy, it will inform best practice if all three steps towards professional progression are designed holistically with this intention at the outset and run in tandem with advances in BIM contracts. The rigour of scaffolded explicit transparency in building regulation compliant educational practices should be taught exactly as it would be required in practice, once the basic regulation concepts and construction sequences and details are understood. It is pertinent as educators in the built environment that we verbalise, acknowledge and act on our duty of care to our

learners to ensure that this is done in a direct, considered and consistent way across all built environment disciplines.

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