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Action Research Evaluation of the Utilisation of ThingLink™ to Provide Immersive Case Based Learning, and its Value on the Learners Experiences

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Abstract

Purpose: Evaluation of an immersive learning tool, ThingLink™, to facilitate case-based learning and its value on the learner's interactivity, engagement, and enjoyment of the module, delivered via self-directed distance learning.

Method: Action research methodology was utilised over an academic year, within which the module utilising ThingLink™ ran three times. An initial pilot project helped to formulate and revise the questions that were distributed via an online survey, gathering quantitative and qualitative data to identify themes within the areas of investigation. Participants consisted of qualified Paramedics within top-up BSc (Hons) and MSc programmes.

Results: 54 responses were received, providing a response rate of 26%. The exploration of data identified themes and sub themes which were explored in depth providing insight into tool accessibility, user experience, and the impact on learning. Overall, it was found that ThingLink™ was easy to use and had a positive impact. Negative factors affecting use and engagement centred on guidance provided, accessibility, and internet connectivity. ThingLink™ increased interactivity, engagement, and enjoyment of the case-based learning experience through the immersive, experiential elements. These allow autonomous gathering, interpretation and rationalisation of data that helps to inform and develop understanding of the patient situation.

Discussion: Findings supported the use of ThingLink™ to provide case-based learning that engaged students and provided a positive learning experience. However, challenges and areas for development were identified which can inform further development and use of ThingLink™. The action research model allows for implementation of changes and further exploration of the impact of these changes within the use of immersive learning to provide engaging and enjoyable learning. The authors believe that this intervention aligns with innovative and creative teaching practices, providing case-based learning reflective of the learner's work experience, making learning relatable, engaging, and enjoyable, which links to the potential for deeper learning and knowledge retainment.

Keywords: Immersive, ThingLink™, Case-based learning, Engagement, Interactivity

1. Introduction

The focus of this evaluation is a contemporary approach to the delivery of online distance learning (ODL) modules for qualified paramedics. Due to advances in immersive technologies, opportunities to enable case-based learning in dynamic and engaging formats have progressed [1].

Emerging research in healthcare and education training highlight the potential benefits of immersive technology including enhanced learning experience, meaningful engagement and learner satisfaction [2,3].

Immersive technology collectively describes the use of virtual reality (VR), augmented reality (AR), extended and mixed reality tools [4,5]. The learner

engages within the created immersive environment through stimulation of the visual, auditory and proprioceptive senses which allows a unique level of cognitive engagement.

Using immersive technology can facilitate alternative forms of simulation for healthcare learners within an online learning environment [2,3,6]. To enhance effectiveness the immersive tool utilised must accommodate varying levels of IT literacy [7], be financially sustainable and accessible over a variety of digital, mobile and desktop-based hardware [8].

ThingLink™ works within a web-based platform, embedded content or app-based tool. In addition to being accessed as a screen based 2D platform, it can also provide an optional VR experience through use of a VR headset or cardboard headset alternative combined with a mobile phone. This provides a range of immersive options for engagement with the learning content [9].

The ThingLink™ platform enabled development of interactive case-based learning materials by the authors, providing an innovative and creative alternative to written case studies.

2. Literature review

A stepwise schematic process was taken for this search strategy across three databases; OneSearch, which encompasses results from a wide range of academic and industry journals, Education Source, and Google Scholar. Full texts of the included articles from the initial screening process were reviewed for eligibility according to inclusion and exclusion criteria. Inclusion focussed on journal articles in the English language within the last 10 years. Blogs and articles published prior to 2012 were excluded. 123 articles were identified, however, when duplicated papers were identified and removed 89 papers remained to be screened for eligibility. Those that were excluded included papers that were not fully accessible, and those that were specific to the use of computer generated VR environments that only utilised headset technologies, where our intended focus was on augmented other immersive technologies, accessible for distance learners. Other papers were removed due to the specific nature of the subject within the immersive learning focus, which were not applicable to exploring student engagement. Following the screening process, 6 articles were identified for review.

Ryan *et al*. [10] report that The Association for Medical Education in Europe guidance on ODL advocates the importance of capturing the diverse, dynamic details of real-world practice whilst offering valuable learning opportunities. Ntaba and Jantjies1 depict challenges within ODL directly and how, within such a diverse learner population, many will benefit from a variety of learning styles, which can be difficult to facilitate in ODL, and many programmes tend to use one or two learning styles for all learners. They go on to claim that inclusion of immersive learning encompasses more learning styles and enhances theoretical knowledge with the inclusion of practical skills.

Ryan *et al*. [10] propose that immersive technologies are based upon constructivist theory and practical learning, allowing the design of learning environments that develop creativity and practical skills whilst improving comprehension of imperceptible concepts. Huang et al. [11] agree, stating that immersive technology provides a cost effective, creative, and innovative learning environment that fosters an active and engaging learning experience, incorporating the psychological requirements to enhance learner engagement and motivation. Following an investigation into immersive technology Huang *et al*. [11] list increased interaction, critical thinking and problem-solving skills, enhanced engagement, and intrinsic motivation as some of the positive effects of immersive technology. Ryan *et al*.'s [10] review concluded that knowledge and understanding gained by the learner is equal between immersive technology and traditional educational modalities, however, they reported that learner enjoyment, engagement and satisfaction was increased.

Huang *et al.* [11] highlight obstacles to the use of all virtual learning such as capacity, technical issues, and disruption. However, Mathew and Mushtaq [12] argue that due to COVID-19 restrictions large-scale development in immersive technology, combined with low-cost computing, has been accelerated, providing an opportunity to drastically renovate education in more creative and innovate ways. Similarly, Andone and Frydenberg [13] argue that widespread availability of reliable and fast wi-fi supports the many immersive technology applications which remain open and easily accessible on a variety of mobile devices. Andone and Frydenberg [13] assessed learners understanding and ability to use and design AR platforms from the TalkTech project, which demonstrated that learners preferred the option to access learning materials via their mobile telephones; ThingLink™ was among the AR applications used within this study and whilst it was a new learning tool for all the learners, on conclusion of the project, learners reported they found AR applications easy to use and felt proficient in the use

of the applications after a short period of familiarisation.

Ntaba and Jantjies [1] identified that ODL can leave learners feeling isolated from peers and lecturers, however, the authors highlight research that suggests the inclusion of AR technology as an instructional tool depicting real-life situations, engaging learners and maintaining their interests whilst providing topics for informal discussion among peers, subsequently reducing the feeling of isolation. Ntaba and Jantjies [1] conclude that learners show enthusiasm towards the use of contemporary methods of education and value the creativity and innovation provided by these new applications. Furthermore, learners have demonstrated their ability to quickly adjust to the use of new and evolving technologies. Ryan *et al*. [10] noted all studies within their review reported elevated satisfaction in learning, self-efficacy, and engagement, however, they recommend a standardised method to evaluate the learners learning experience, ensuring a consistent approach to better inform research. This would allow development of a curriculum that includes immersive technology alongside traditional teaching methods, which is guided and informed by evidence-based research [10]. Mathew and Mushtaq [12] agree and stress that inadequate implementation and poorly designed evaluation could impede future development.

Further research is required to consider the application of learning in simulation to real life practice, particularly in clinical environments, to avoid any negative impacts upon the healthcare system. Whilst more standardised evidence is required, Huang et al. [11] conclude that the use of immersive technologies offers the possibility to provide interactive experiences and simulation activities that supplement traditional teaching approaches and create potential for innovative online learning in education curricula as well as professional training.

3. Methods

3.1. Overview

An action research methodology was utilised to evaluate the impact of ThingLink™ on engagement and enjoyment of a module from a learner perspective. The fundamental purpose of action research is to examine an area of existing practice to assess potential developments or identify strategies for change [14,15]. Within the process of critical evaluation and exploration of outcomes researchers may gain credible insight from the themes identified.

Following the results of a pilot study exploring learner experience of ThingLink™ case studies, a new survey was developed to better evaluate the impact of the immersive case studies on enhanced learner enjoyment, interactivity, and engagement. This restructure allowed greater exploration and insight of the themes identified.

3.2. Participants

Learners enrolled on the distance learning module were voluntarily recruited to participate in this research. Ethical approval was gained prior to distribution of the survey, which was disseminated on the module announcement board and not sent directly to learners, to ensure participants did not feel pressured or coerced into completion; a reminder was posted prior to closing of the survey.

3.3. Procedure

An online, anonymised survey was designed using Microsoft Forms. The survey, comprising of 8 questions, explored whether the inclusion of ThingLink™ case studies, within the learning materials of an ODL module, increased learner interactivity, engagement and enjoyment of the module. A combination of quantitative and qualitative data were gathered using Likert scales and open text answers to gain insight into the learner perspective and the identification of themes.

Survey respondents were informed that the data would be used for research and publication purposes, therefore written consent for the use of responses was requested and recorded at the start of the survey. Opportunity to withdraw responses was provided up to the point the survey was closed. This was facilitated via anonymised key words that would allow their associated data to be withdrawn without revealing participant identity. The data was gathered through three consecutive cohorts over the full academic year.

Data cleansing was completed with responses that applied to the module structure or delivery redacted as the responses were not relevant to the evaluation of the ThingLink case studies themselves.

3.4. Analysis

202 paramedic learners enrolled on an online distance learning module between September 2022 and April 2023. All these learners were invited to participate in the evaluation. 54 responses were received, giving a response rate of 26%. All 54 respondents answered all the quantitative questions.

Data were analysed using built-in Microsoft Forms analytics for quantitative responses. Open text answers were interpreted qualitatively to identify themes [16].

The use of thematic analysis is flexible in its application and allows the researcher to relate themes and draw conclusions about what was learnt. This is beneficial in identifying concepts and ideas from within the raw data, enabling discussion around the key themes that are uncovered during analysis, providing valuable information [16,17].

During the exploration of the qualitative data collected during this research, themes and sub themes were identified. These themes are explored in depth below and have been organised to provide insight into tool accessibility, learner's ability to use the immersive tool, the user experience of the tool, and the impact on their learning.

4. Findings

4.1. Theme 1 − Accessibility and guidance

82% of the respondents indicated they found the guidance and support provided by the lecturers on how to locate and access ThingLink™ case studies clear and easy to follow. 6% neither agreed or disagreed and 13% disagreed or strongly disagreed with the statement. Sun and Rueda [18] report that learner computer self-efficacy is vital in ODL, previous training or experience with technology has a substantial impact on learners' engagement in the learning process. Therefore, it is important to ascertain if the current support and guidance provided is sufficient to sustain ease of access and use of the platform utilised in this research, ensuring a balanced learning opportunity across the learner population.

4.2. Sub theme 1.1 - Provision of guidance

A Likert scale that focused on the provision of guidance that explained the use and navigation of the immersive case study was provided. 44% of respondents agreed that the guidance provided did not require development, 24% remained neutral and 26% felt the guidance could be improved further.

Within open text responses respondents highlighted uncertainty that they had accessed all pertinent patient information placed as hotspots within ThingLink™. Video guidance on utilising the accessibility tool enabled within ThingLink is provided, use of this tool would resolve any concerns of missed patient information, however this appears to

have been overlooked. Therefore, clearer signposting to this tool will be provided, if the uncertainty remains then learners can be provided with the number of information points located within the ThingLink™ to ensure they have retrieved all information.

Adoption of modern technologies by learners is often impacted by the learner's familiarity with the technology or the guidance provided to enable them to easily engage with and navigate the technology being utilised. Nicol and Macfarlane-Dick [19] recommend provision of clear task requirements to promote learner understanding and formation of ownership. Unrestricted access to guidance videos, to guide through the task brief in relation to utilising the immersive case study, were provided with the intention to ensure clear direction, and understanding [8].

4.3. Sub theme 1.2 - Thinglink™ accessibility and ease of use

82% of the respondents agreed or strongly agreed that the immersive tool was easy to access and use while 6% remained neutral. 13% disagreed and 28% felt that whilst the guidance was clear, they still had difficulty using ThingLink™

Respondents were asked if they thought guidance was clear, but the tool was difficult to access and use. The majority (67%) disagreed or provided a neutral response to the survey question. This supports that for most learners both the guidance and accessibility of the tool was sufficient to enable a positive experience.

The feedback does highlight the need to continue offering alternative formats of the case studies to ensure that learners who are unable to navigate the technology, are not placed at a disadvantage and quality learning can still be undertaken. This is affirmed in the open text responses where several respondents demonstrated frustration with their personal hardware and its differing ability to navigate and use ThingLink™. This frustration may have fed forward into their responses on the enjoyment and interactivity elements of the survey, potentially skewing the data:

> "Tool was slow and froze on my laptop."

> "On a slow computer I struggled to load this and could potentially miss out on information"

One respondent stated that the inclusion of ThingLink™ is "poor and unfit for purpose"; there is no elaboration on why the learner holds this view. However, scrutinising the feedback, it appears the

learner experienced poor internet connectivity which could have led to frustration whilst using the application, prompting an overall negative experience and subsequent negative feedback.

Owusu-Agyeman and Larbi-Siaw [20] establishes a link between learner-content engagement and mediation of technology; learners within their study revealed that challenges to the use of immersive technology included robust learning platforms, constant internet connectivity and the adaption to the learning platform employed. However, Huang & Liaw [21] hypothesised that learners perceived self-efficacy impacts their perception of ease of use, which was not explored within this cycle and may be considered within further research. To support learner adaption to the chosen learning platform video guidance and early introduction to the platform has been facilitated within the module, reliable internet connectivity cannot be impacted by the researchers however this is a necessity for all distance learning and must be procured by the learner.

4.4. Theme 2 − User learning experience

Barnett *et al.* [22] conducted a comparison study which highlighted learners who utilised virtual simulation-based case studies over the traditional paper-based case studies demonstrated increased engagement with the learning process. Situational learning allows for acquisition of knowledge within an environment replicating that in which the learner must apply their knowledge and skills. This increases the effectiveness of learning outcomes [3] and aligns with the constructivist theory, whereby meaningful knowledge is actively constructed from the individuals experience [8].

4.5. Sub theme 2.1 - ThingLink™ interactivity

6% of learners disagreed or strongly disagreed that the inclusion of ThingLink™ improved interactivity on the module. The learners expressed through open text feedback that further developments to increase interactivity would improve the experience:

> "More zoomed in pictures to show evidence. The observations could be included in the ThingLink, so they look like they are on a monitor for example."

> "Video in place of picture may enhance the experience/ The ability to interact via typing a response, appreciate this may be limited. However, this could allow a number of different diagnosis to be investigated − immersing the learner."

During the research cycle, patient information within the case studies was provided using short voice recording clips or small segments of written information, there is scope for the inclusion of more varied and direct information from the case study patient via short 360-degree video clips or generative artificial intelligence, however use of these tools at present would restrict the ability to manipulate or change the medical presentations, AI technology at present reduces the fidelity of the patient appearance and vocal quality, which provide key visual and aural information to the learner, however development of these technologies has been fast and will no doubt produce valuable opportunities for their use in the near future.

Overall, 78% of respondents agreed or strongly agreed that the inclusion of ThingLink™ increased the interactivity of the module. The open text feedback provided insight into the learner experience, highlighting that they valued the realism and immersive approach to the case studies.

> "Great interactive tool to enhance the case based experience … better than reading"

> "The ThingLink™ was useful, worked well and I liked how provided interactivity with the module."

> "I found it useful having the sound function to hear the patient talking and hearing how short of breath they were."

> "Thinglink™ was pretty interactive ….Falling short of actually walking around the house physically, the ThingLink enabled a chance to visualise and virtually walk through the scenario."

Feedback suggests that learners enjoyed creative and contemporary approaches to learning and consider the immersive case study reflects purposeful connection to real world application. Whilst it is assumed most learners access ThingLink™ through a web-based platform on a computer, laptop or mobile device, future research could consider the differing interactive experiences based on how the tool is accessed particularly for learners that have the benefit of a VR headset or Google Cardboard type device alternative.

A study by Peterson, Petkakis and Makransky [23] exploring the value of the Cognitive Affective Model of Immersive Learning (CAMIL), developed by Makransky and Peterson [24], suggests that the degree of immersion and interactivity have unique effects on aspects of learning related to the experience of agency and situational interest which, in themselves, have a positive impact on learning.

Interestingly, they report that the effect of inter-activity increases when immersion is low. Studies by Bhowmik *et al* [25] and Bracq *et al* [26] highlight that the greater the perceived sense of immersion, the greater the enhancement of knowledge, skill and learning that users reported.

4.6. Sub theme 2.2 - Enjoyment of learning experience involving ThingLink™

The Likert scale exploring enjoyment using the immersive tool identified that 15% of respondents did not feel they enjoyed using the tool. As this percentage is reflected through the negative responses to previous questions it is likely the same learners have had an overall negative experience of the tool:

> "Unnecessarily elaborate for what it's used for."

> "Took a bit of time to get used to how it worked and trying to remember where to go to find out the information."

Conversely, 63% of respondents agreed or strongly agreed that they enjoyed using the tool:

> "Simulates a patient environment which adds realism."

> "More fun."

> "Really enjoyable addition to the module rather than the information written down."

> "Unique and creative way for myself to think about the case study."

This positive finding supports future use of ThingLink™ within appropriate modules and continuing research on the benefits of its application within ODL. However, it is still important to establish if the intervention meets the needs of a diverse learner population by reflecting on the open text suggestions and making further improvements. Ensuring a greater percentage of future cohorts enjoy the learning experience will promote positive engagement with the learning content.

Lucardie [27] claims that there is a valuable link between enjoyment, successful learning, and knowledge absorption. Therefore, creative approaches and methods that promote enjoyment are expected to increase enthusiasm and optimism within the learning experience. Holly *et al* [28] observed that an immersive experience, motivated learners and engaged them in furthering their learning. Both these views support the review by Ryan *et al* [10] which identified that immersive learning technologies increased enjoyment and engagement as well as improving satisfaction with the educational experience.

4.7. Theme 3 —impact to learning experience

The impact of using ThingLink™ on the learner's experience was explored utilising free text. Within this theme areas of positive impact centred on greater awareness of the patient surroundings, facilitated through the more realistic experiential elements that are enabled within the use of immersive learning tools:

> "Made the case study more real and therefore writing and researching easier."

> "Allows me to better picture the case and scene."

The visual engagement that ThingLink provides allowed users to gather and interpret information within their critical appraisal of the clinical situation as would be performed by clinicians within patient's home:

> "Visualisation and audio has allowed me to process information as if on a real incident. This has allowed deeper thinking about scene safety, patients demeanour and surroundings"

It was identified by respondents that this would not be achieved within the use of written case-based learning:

> "Thinglink™ was beneficial at simulating an awareness of patient surroundings, such as medications or medical equipment on shelving to gather a wider history. This would not have been possible with a written or verbal scenario so added a beneficial additional layer to assessment."

> "The interactive element allowed me to assess the scene in my own way and not from a list made by someone else."

The immersive exploration of the case study allows for the autonomous gathering, interpretation and rationalisation of the clinical bio/psycho/social data that helps inform and develop understanding of the patient situation for clinicians. This allows for depth of engagement, by learners, into the reality of the patient situation:

> "Being distance learning it assists catering for other learning styles - for me personally, a visual element helps more than just reading words describing a scene."

"Visualisation and audio have allowed me to process information as if on a real incident. This has allowed deeper thinking about scene safety, patients demeanour and surroundings."

"It was good to have a visual aid to work with, it helped me to really visualise the patient and their circumstance."

Thistlethwaite *et al's* [29]. review of Case Based Learning (CBL) found several studies which identified that learners preferred various IT based case studies, with learners feeling that e-learning increased understanding, independent learning and critical thinking skills. Providing CBL within an immersive tool adds to the experiential nature of the situation, creating presence which increases learner motivation and, in turn, allows for a deeper level of processing [8]. This is explored by Makransky and Peterson [24], in creating the CAMIL model of immersive learning, they identified that a learner's presence and agency, which occur through immersion and interaction, will be higher in more immersive teaching modalities and that learning will be greater where presence or agency are higher. Piccone, Collett and DeFoe [30] also found that greater active engagement in immersive learning produced higher levels of agency for learners. There is some earlier challenge to this with Fowler [31] positing the argument that there are optimum levels of fidelity and interaction in relation to learning, with the cost of achieving these providing argument against, due to the high level of investment required to achieve a positive return. However, technologies have moved on even in this short time, with increased levels of immersion being available for lower costs as technology develops. Overall, this provides further consideration to explore how learners engage with ThingLink™, and whether a more immersive experience increases learning or if the lesser immersive nature of the platform-based modality increases the impact of interactivity and therefore agency. Ultimately scrutinizing what effect each experience may have on the learner's perception of learning.

Spies and Botma [32] suggest that authentic scenarios will enhance engagement and motivate improved use and performance. Overall, the comments on the impact of the learning experience were positive. Given the potential differences in demographic and educational experience, this is encouraging for the use of technology-based modalities.

5. Discussion

This action research has identified and evaluated emerging themes from the inclusion of ThingLink™ AR case studies, for learners enrolled on an ODL module, that employs a practical OSCE for summative assessment. The action research aimed to analyse the extent of which this intervention supported learner engagement and enjoyment, including a sub theme on guidance and application accessibility. The responses demonstrate that many participants had an overall positive experience including, increased interactivity, enjoyment and felt guidance was sufficient to support access and navigation of the immersive platform.

The data suggest the intervention was considered enjoyable, interactive, and engaging by learners, whilst no data of actual learning has been verified, increased enjoyment and engagement is linked to deeper learning and knowledge retainment. Therefore, the authors believe the intervention aligns with innovative and creative teaching practices and varies teaching methods, subsequently providing learning in a format that reflects the learner's daily work environments making learning relatable, engaging, and enjoyable.

As indicated within the learner feedback the ThingLink™ platform is reliant on good internet connectivity and technology efficacy, therefore learners with poor connectivity had a negative experience due to slow download speeds or unreliable connectivity, poor device suitability, and difficulty manoeuvring around the case study scenario. Whilst alternative formats were available the negative experience possibly impacted the research data.

The use of Likert scales included scaling for multiple questions with open text areas for further explanation on the grading provided and additional suggestions and comments in relation to the primary question with a suggestion that comments be limited to three key points. This focused open text question for each point hoped to ensure the data remains centred on the research aims but may restrict learner response to their more pertinent points rather than provide a wider, more balanced feedback on all the questions. Future research cycles would review this approach to develop further opportunity for insight, whilst remaining focussed on the research questions.

The emerging themes demonstrate that, whilst there are areas that could be developed further, most of the data from the survey imply the intervention had a positive influence on learner enjoyment and increased the level of interactivity within

the module. It is recognised that only a small number of learners participated (26% response rate), and that the interpretation of the findings included within this study are subject to researcher bias. In order to mitigate this during this cycle, an academic colleague collated and reviewed the data and interpretation prior to publication.

6. Limitations

Limitations included the small sample size and the impact of the Likert scaling on limiting open text responses. This research has highlighted that future action research cycles require specific survey questions to allow learners to directly identify challenges that may be resolved, avoiding overall negative feedback from one element of the experience whilst guiding future developments. As highlighted within the literature review it is difficult to measure efficacy to practice due to the lack of focused research across the large amount of immersive technology platforms.

Freitas et al. [33] highlight the quick advancement of numerous immersive learning platforms to facilitate learners having to study via ODL, such as during Covid-19, subsequently making it difficult to obtain credible literature specific to one immersive platform. This was evident on performing the literature review; whilst a vast amount of evidence on immersive technology was available, ThingLink™ specific evidence was limited, therefore further research is required to truly validate the impact of the application in HEI.

7. Conclusions

Overall completion of this action research has provided opportunity to encompass learner perspectives and drive change, adopting a flexible, reactive approach whilst remaining open to diverse innovation with authentic learning tasks. The developments have simultaneously promoted enjoyment to enrich learners' learning experience and academic journey.

Further research specifically on ThingLink™ and its impact on enjoyment and engagement is required to achieve credible research insights. Whilst this action research did not adopt a standardised approach, this will be explored with the wider academic team with an aim to formulate a consistent approach to ensure future action research into ThingLink™ is structured, which will enable comparison of the data to ensure positive advances are made.

The researchers hope that sharing learning and disseminating the findings of this research may encourage the inclusion and further research into other immersive technology software. This will enhance the evidence base of the utility of these tools, specifically in the online distance learning setting, where research is more limited. This will support development of approaches to learning, teaching, and assessment practice. This approach also empowers a shared learning culture, consequently promoting growth and professionalism throughout the delivery of clinical education. Finally, this research will support and underpin larger scale immersive projects and research in the future.

Conflicts of interest

The authors do not work for or have any commercial or financial interest in Thinglink™. The HEI for which the authors work has purchased a subscription to Thinglink™ and are keen to evaluate its use within a variety of teaching and learning applications. There is no financial connection to the company, nor has any support, financial or otherwise, been received for the completion of this research, from Thinglink™ or any other external parties.

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