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Evaluation of eye animations developed to aid undergraduate student orthoptists

In orthoptics we often explain dynamic concepts with traditional media, such as static images which students can have difficulties understanding. With advancements in technology, we were able to develop some animations to simulate eye abnormalities. The aim of this study was to incorporate these eye animations into the teaching of orthoptics at the University of Liverpool, and evaluate their use, based on student perceptions, in terms of usability and efficacy. Results showed that students responded positively, valuing the visual element of the animation resource, the user friendliness and the flexible accessibility. The themes identified during exploratory analysis were similar from the questionnaires and the focus group. These themes highlighted that the students positively evaluated the animations and would like to continue utilising them further, commenting positively on the formatting and the ease of use of the animations. The flexibility of access, the user friendliness and visual element of this resource were all evaluated very positively, thus increasing student confidence and experience prior to attending clinical placement.

Keywords: learning technology, animations, orthoptics, student perception, student experience, pedagogy, higher education, orthoptic education

Introduction

Technology can provide an important role in learning and teaching due to the integration of functions, often enhancing education for both the teacher and the learner (Gallardo-Echenique, Molias, & Bullen, 2015). The inclusion of modern technologies into teaching practices is rapidly increasing (Baxter & Hainey, 2018). It is clear to see that the inclusion of technologies that are able to replicate or simulate various clinical scenarios outside of a clinical setting would be advantageous to healthcare students (Baxter & Hainey, 2018).

With a current generation of students who have been exposed to a wide range of advancing technology both at home and in an educational setting, it may be appropriate to assume students would expect the incorporation of new technologies in

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teaching and learning designs and would adapt with ease (Domingo & Gargante, 2016). However, often it is suggested that education must adapt for the needs of younger generations who are more digitally minded, yet these conclusions come with little evidence (Bennett, Maton, & Kervin, 2008). Therefore, the previous notion of an age-related divide is not as simple as originally thought, emphasizing that the pedagogical foundations require exploration.

Constructivism theorists have postulated that interactive activities in which the learners play active roles are more effective than passive activities (Huang, 2002), thus supporting the use of interactive technology in a learning environment. However, any technological advancements should be well designed to allow a balance between problem solving, interactivity, and support, ensuring the pedagogical considerations are factored into the design of the resource. In addition, it is important to note that students, particularly health science and nursing students, often do not see the incorporation of technology as a replacement for traditional teaching methods, but rather as a supplementary resource, emphasizing the value of a blended learning approach (Li et al., 2021; Shenoy & Kuriakose, 2016).

Current knowledge surrounding technological advancements in education has resulted in the development of many learning technologies across multiple disciplines (Gallardo-Echenique et al., 2015; Hwang, Tam, Lam, & Lam, 2012; Trevisan, Oki & Senger, 2009). However, advanced technologies specific to orthoptics are somewhat limited and therefore require development. Research has demonstrated that teaching resources in the form of animation can support the students in understanding key concepts and contribute to improving exam results (Hwang et al., 2012; Trevisan et al., 2009). In orthoptics (which encompasses the study of eye movement disorders) we often need to explain dynamic concepts (changes in eye movements, direction, speed, accuracy) using traditional media, such as static images explained by staff, which requires their presence. Students can have difficulties understanding these key concepts until they attend clinical placement and see the conditions in real life, supported by a clinician, but there can be a gap of many weeks between the university-based teaching and clinical placement.

In addition, there is a growing need for materials that can be used by students to enhance their learning outside of the university. This can support students from a widening participation background, with learning difficulties, or when addressing cultural diversity, but also maximizes face-to-face staff time. Therefore, animations to simulate eye abnormalities were created to aid students in understanding key concepts, as such resources are currently unavailable. In the first phase of development, we created animations based on one key orthoptic assessment (the cover test) and different types of strabismus (eye misalignment) it can detect. A series of animations have been created where the students can vary a number of key parameters and view from the orthoptists or patient's perspective.

The research question this project intends to answer is: how will orthoptic students perceive the animations as a teaching and learning tool? Based on this question the aim of this project was to incorporate these animations into the teaching programme and evaluate their use based on student perceptions in terms of usability and efficacy as a teaching and learning tool. The students' responses were analysed to inform further developments of the animations. Changes in the animations were incorporated into teaching in the following academic year, and students again had the opportunity to provide feedback.

Methods

The study was approved by the Committee on Research Ethics at the University of Liverpool and informed consent was obtained from the students prior to undertaking the project.

Animation development

The animations were created using Adobe Animate CC and were made available to access on a desktop or a laptop computer. The eyes were created using a photo of a real iris.

The cover test is a relatively simple test, requiring one eye to be covered at a time and movements in either eye observed. However, there are a number of variables that need to be observed with these movements such as the direction, speed, accuracy, and changes in the movement during the test, which is performed with the patient looking at a light, then a target at near (33 cm) and a target in the distance (6 m). The clinician shows the patient a light and initially observes the position of the corneal reflections, then each eye is covered in turn. Following this there is an alternate cover test where the occluder moves from one eye to the other without allowing the patient to use both eyes at any time, and the movement when the cover is removed is also noted. All of these factors were built into the original design of the test, as shown in Figure 1. In addition, the students could choose the patient view, to aid in their understanding of the reasons behind the movements.

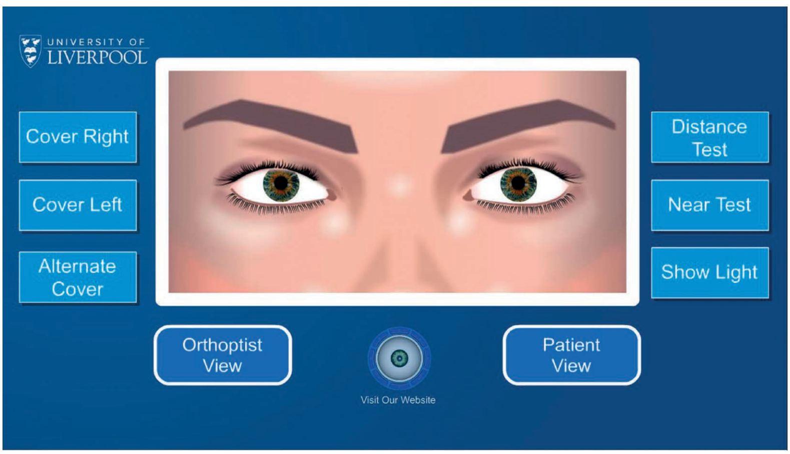

Figure 1 Screenshot of the original test design.

Phase 1

First year undergraduate orthoptics students attended a lecture to introduce the topic of the cover test and its use in detecting strabismus. This session involved all students together, utilizing a PowerPoint presentation with the slides being made available to the students online immediately after the session. Students were given the opportunity to ask questions within the session, as usual. Following the session, the initial animations were released for students to use in their own time. A second lecture was then delivered covering the classification of the types of strabismus and how the results of the cover test are used to aid in the classification.

Five days later students attended a computer lab session, supported by two members of staff. Students used the rest of the animations (covering the different diagnoses) following a self-directed worksheet. At the end of the session, students were asked to complete an online evaluation form, incorporating the following questions. Questions 1–7 were five-point Likert scale responses, the remaining questions were free text responses.

Q1. The animations were easy to use
Q2. The animations had a positive impact on my learning
Q3. I would like to use the animations again
Q4. The animations were formatted appropriately
Q5. I did not encounter any technical difficulties when using the animations
Q6. I enjoyed using the animations
Q7. The animations could be improved further
Q8. Please explain how the animations impacted on your learning
Q9. Please provide details as to how you think the animations could be improved
Q10. If you encountered any technical difficulties, please could you explain what those were?

Free text answers were analysed using thematic analysis. Key themes were identified deductively as important concepts were already identified. A list of codes was created and further analysis was undertaken using the framework approach.

Focus groups

Three weeks later, after the students had the opportunity to use the animations in their own time, students were invited to participate in a focus group to provide further detailed feedback. Allowing the students to voice their opinions and share experiences enables positive development to the animations. The free text responses from the questionnaires were evaluated and explored further within the focus group. The focus groups were semi-structured, with a topic guide being created based on the responses from the online questionnaires. Questions were related to the usability of the animations, impact on learning, and continued and future developments.

The focus group was face to face and recorded via an audio device. Focus group transcripts were analysed using thematic analysis to explore students experiences and perceptions. This analysis method allowed the researchers to make sense of the data through reflexive discussions, whilst identifying, analysing and reporting patterns and themes (Braun & Clarke, 2006). Some key themes and concepts were identified deductively, as from reading of current literature, academic experiences, and the analysis of the questionnaires, some important concepts were anticipated (Trevisan et al., 2009).

For analysis of the focus groups, the audio recordings were transcribed into verbatim scripts by a member of the research team to allow familiarization of the data. During transcription participants were anonymized. Once transcription was complete, manual coding was undertaken. A framework approach was taken to identify key topics and codes to enable organization and description of the data. The topics and codes were then compared within a framework to develop the final thematic sentences (Gale, Heath, Cameron, Rashid, & Redwood, 2013).

Phase 2

Following analysis of the feedback, changes were made to the animations. The changes made included:

- corrections made to errors identified by students
- addition of new types of strabismus
- addition of a new test to assess motor fusion.

The updated animations were then incorporated into the teaching of the new first-year cohort. The same online evaluation form was used with this new group of students after the students had received the same level of teaching as the previous group prior to accessing the animations.

Results

Questionnaire responses

Responses to the questionnaires were obtained from thirty-one students (84% of the cohort) in phase 1 and twenty-eight students (72% of the cohort) in phase 2.

Table 1 Responses to the Likert questions in both phases in percentages

	Strongly agree		Agree		Neither agree nor disagree		Disagree		Strongly disagree	
Phase	1	2	1	2	1	2	1	2	1	2
The animations were easy to use	80.6	85.7	16.1	14.3	3.2	0	0	0	0	0
The animations had a positive impact on my learning	61.3	82.1	38.7	17.9	0	0	0	0	0	0
I would like to use the animations again	83.9	71.4	16.1	25	0	0	0	0	0	0

	Strongly agree		Agree		Neither agree nor disagree		Disagree		Strongly disagree	
The animations were formatted appropriately	74.1	67.9	25.8	32.1	0	0	0	0	0	0
I did not encounter any difficulties when using the animations	48.4	39.3	25.8	32.1	0	7.1	0	21.4	0	0
I enjoyed using the animations	64.5	71.4	29	28.6	6.5	0	0	0	0	0
The animations could be improved further	19.3	0	25.8	28.6	41.9	27.6	0	39.3	6.5	3.6

Note: Where totals do not add up to 100% this indicates a lack of response to the question

Free text responses from phase 1

After exploratory analysis of the free text responses, the following three themes were identified:

1. Students valued the flexibility of the resource

Many students commented that they valued the ability to access the resource in their own time and spend as long as they wished observing the animation. It was commented that this was something that they were not always able to do in a clinical environment.

2. Students sought additional content

From the question relating to improvement, 26% of students requested additional content, rather than making specific improvements to the existing content. The additional content related to more clinical scenarios. Some students also asked for the animations to have annotations with detailed answers and advice on how to record each clinical scenario.

3. Students reported minimal technical difficulties

Many students reported that they had no difficulties accessing the animations. A few students had difficulties accessing the animations in one particular browser. Two students reported a minor error with the patients view on one of the animations.

Figure 2 demonstrates the changes in opinions between the two questionnaires. More students strongly agreed with the statements regarding ease of use (question 1) and that the animations had a positive impact on their learning (question 2). However, more students disagreed with the statement that they had no technical difficulties (question 5) and more disagreed with the statement that they could be improved (question 7).

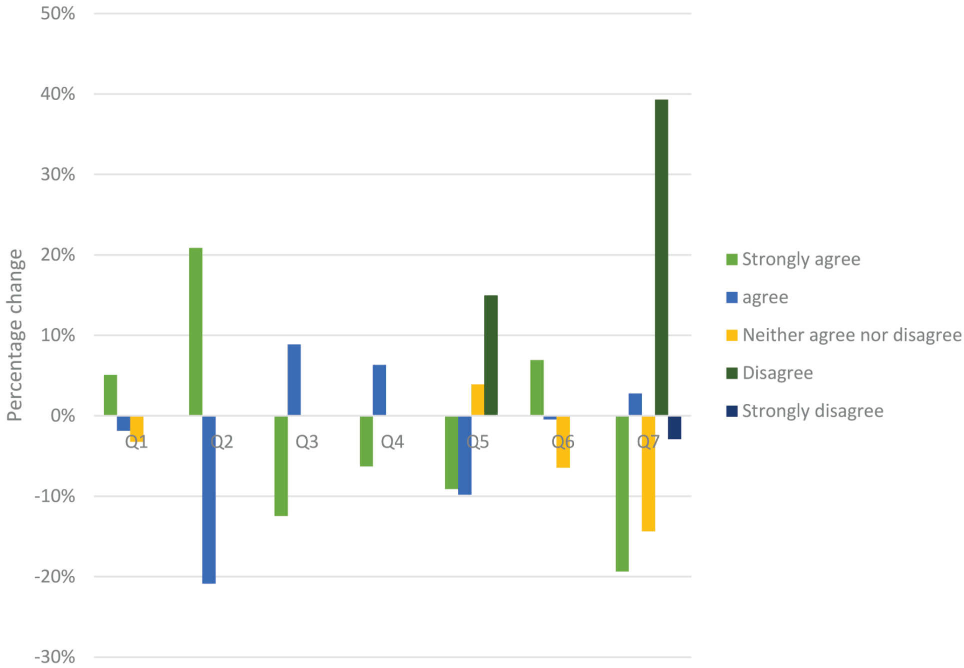

Figure 2 The change in responses from phase 1 to phase 2. A positive response indicates an increase.

Free text responses

After exploratory analysis of the free text responses the same three themes were identified as before:

1. Students valued the flexibility of the resource

Students again reported that they found the resource useful as they were able to access the animations at their own pace and repeatedly if required. Some students reported that this improved their confidence for clinical placement. Some students also stated that they found it useful visualizing the deviation in this format rather than learning the content and the clinical skill separately.

2. Students sought additional content

Students in phase 2 still required additional content. In particular students seemed to want the correct answer to be displayed within the animation itself. Students also requested advice on how to record each clinical scenario. Positively, students again requested more clinical scenarios to access in this format.

3. Students reported minimal technical difficulties

There were less technical difficulties within phase 2. A minor error was picked up with scenario 5 and there was a technical error with the newer scenario in which one of the buttons did not work. No problems were reported about accessing the animations due to specific instructions as to which web browser to use in this phase. Despite less difficulty, as all students picked up on the minor error, the score on the questionnaire actually decreased in phase 2.

Focus group: Thematic analysis

Transcripts of the focus groups conducted in phase 1 were analysed and five main themes emerged using the framework approach:

1. The platform utilized was user friendly

Students found the platform that was used to build the animations extremely easy to use. It was commented that the buttons implemented in the animations were laid out in a logical format and were straightforward.

> 'Easy to use, laid out well and very obvious where everything is'

There was one technical difficulty noted by a student where one of the buttons within an animation was not working.

2. Students value that the learning resource can be accessed in their own time and at their own pace

Students valued that they could access the animations on and off campus. They appreciated that they were not timed and they could access them at their own pace. It was commented that this was something that they were unable to do in a clinical environment.

> 'You have time to observe more things and ask questions'

3. Students valued the visual element of this resource

Students acknowledged that they did not often see strabismus unless they were in a clinical setting. Therefore, it was valued that the animations gave them the opportunity to view an abnormal result of a clinical assessment before attending clinical placements.

4. The resource was an additional resource to support prior learning

Students indirectly acknowledged that the animations were an extra resource to support their prior learning. They specifically mentioned making use of other resources previously provided to try and work out the strabismus classifications.

5. Further content is desirable

Students provided positive comments regarding the animations and when asked what they would like improving, they asked for further scenarios and built-in questions to support learning, more so than specific improvements to the animations.

Discussion

The results of the eye animations used by undergraduate orthoptics students showed that students responded positively, valuing the visual element of the animation resource and the user friendliness. They also valued that the animations were accessible at all times, and they could take their time working through each animation in an academic setting or at home. The themes identified during exploratory analysis were similar from the questionnaires and the focus group. These themes highlighted that the students positively evaluated the animations as an additional resource and would like to continue utilizing them further, with them commenting positively on the formatting and the ease of use of the animations.

Findings are in support of previous studies that have looked into the use of animation in higher education. For example, research has suggested that animations can be used to deliver teaching content in an alternative format that is more practical and interesting to the student (Chan, 2013). The feedback from our study supports this due to the positive responses obtained by students. In addition, studies have also found that the presentation of teaching material in an alternative format such as animation can increase motivation therefore increasing productivity and learning (Wang & Reeves, 2006). Although this was not something that was directly evaluated in this particular study, it could be assumed that this may have been the case with our cohort as 100% of the students either agreed or strongly agreed that the animations had a positive impact on their learning. To evaluate this further, additional analysis based on attainment could be looked at in the future, rather than focusing on student perception alone. Despite the positive responses, it is important to highlight that often students do not value the replacement of traditional teaching methods with technology enhanced learning, therefore they are to be utilized as a supplementary resource to support learning and understanding (Li et al., 2021; Shenoy & Kuriakose, 2016).

Practice implications

Generally, the use of animation has increased in education, particularly for individuals with specific learning difficulties, such as dyslexia (Chan, 2013). The inclusion of advanced technologies has shown to improve inclusivity across differing cultures, with a well-designed platform showing no significant differences between home and international students (Hannon and D'Netto, 2007). Animation use in education has also been shown to aid in the understanding of various concepts across multiple topics for both students with and without dyslexia (Taylor, Duffy, & Hughes, 2007). Although this particular study did not individually investigate those with specific learning needs, we are aware that the cohort was inclusive incorporating specific learning needs and cultural diversity, with results showing no obvious differences in findings across the cohort. The number of students who agreed or strongly agreed that they would like to use the animations again was 100%, emphasizing that the resource may be aiding the understanding of topics. Therefore, including additional resources for students in varying formats increases inclusivity of a programme, which will ultimately enhance engagement and student satisfaction.

Although not evaluated in this study, it is also important to consider socio-economic factors when incorporating technology-enhanced learning in to a programme. Whilst elements of technology-enhanced learning and online learning can sometimes increase inclusivity, allowing students to access resources remotely, this may not always be as simple for all students (Godard, Selwyn, & Williams, 2000). Previous studies have reported that availability of technology and cost can often be a barrier to learning (Venkatesh, 2001). Therefore, to ensure that this is addressed when incorporating the animations into the orthoptic programme, accessibility has been considered. The animations are available to access on and off campus, but are also incorporated in timetabled sessions to ensure those who may not have the connectivity or resources at home are still able to benefit from the learning tool.

Research implications and limitations

Despite the success with the animations and the perceived learning from the students, there were several study limitations highlighted. The animations were created as a stepping stone to help students transition from the clinical skills lab in the university to a clinical placement site. This allowed students to artificially assess a patient with strabismus, which is often something they cannot do until they get to their clinical placement site. Although students said this would increase their confidence, a disadvantage was that the eyes were moving on a flat plane during the animation, which is not real to life. While the introduction of the animations on a flat plane is still perceived as an advantage that previous students did not have, the university does have some 3D animations available in which further development of these could be considered to enhance the resource further. The development of a 3D resource enhances the realism which adds to the learning experience further. It has been shown that providing a sense of realism does add much more to the learning experience than traditional resources in medical education (Sattar et al., 2020).

Additional study limitations included the relatively small cohort of students used in this study and the fact that the study focused on student perception rather than attainment. The small cohort however is representative of the numbers in a year group on the orthoptic programme at the University of Liverpool. It was also important to focus the animations on the discipline of orthoptics, as this is an area where there are limited specific technological advancements in teaching. In terms of evaluating perception, it was also important in the first instance to enable us to determine whether the students would engage and value the animations. Now that we have concluded that they are positively valued we can consider looking at student attainment. However, this requires careful thought due to the large number of variables across students and year groups, and care must be taken to not disadvantage student groups by restricting access to a valuable resource that may enhance learning.

With new inclusions of advanced technology into education, it is important to manage expectations (Brown, Thomas, & Thomas, 2014). For example, students requested built-in answers in the programme which would allow them to access the answers at times without trying to problem solve themselves. Whilst it is important to listen to the student voice when developing technologies for education, it is important to note that it is not the only one. Other important factors to be considered are technical advances, support services, and pedagogical reasoning. Therefore, management of expectations may need to be considered when including student input due to the high expectations surrounding educational technology (Gosper, 2013). Whilst the inclusion of answers may be useful to the student, they should be aware that this inclusion may also hinder the learning process. Research has shown that critical thinking, including interpretation and analysis of a scenario, is a necessary skill in higher education and the wider context. Implementation of problem solving in specific learning methods can often improve learning and overall student achievement (Fatoke, Ogunlade, & Ibidiran, 2013). Therefore, whilst the addition of further information may be beneficial, there needs to be a balance to allow the students to try and work their way through the scenario themselves.

In conclusion, the results of this research indicate that eye animations used in this specific context are perceived as a useful resource to aid student learning and improve confidence prior to attending clinical placement. The flexibility of access, the user friendliness, and most importantly the visual element of this resource were all evaluated very positively, thus increasing student confidence. While the technology could be enhanced further, it appeared the students would prefer more scenarios with additional content using the same or a similar platform. The eye animations will not replace any current resource but will be utilized as an additional resource for undergraduate students on the orthoptic programme at the University of Liverpool. The information obtained from this study will inform the next stage of development which will include further clinical scenarios, with the addition of audio guidance and interactive questions.

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Focus group analysis

List of codes

1. **Technicalities**
   1.1: User friendliness
   1.2: Technical difficulties
2. **Perceived learning**
   2.1: Flexibility
   2.2: Pace
   2.3: Additional Resource
3. **Improvements**
   3.1: Extra resources

Framework approach

1. Technicalities

	Focus group responses	**Analyst comments**
User friendliness	Students found the animations easy to use. 'Very easy to use and easy to find everything, really straight forward' 'Easy to use, laid out well and very obvious where everything is'	After further analysis of the sub categories within this topic the following thematic sentences have been created: • The platform utilized was user friendly.
Technical difficulties	A couple of students identified that there was a button that was not working within one of the animations. Another student mentioned that the eye animations were not accessible for a period of time when the website was undergoing changes.	

2. Perceived learning

	Focus group responses	Analyst comments
Flexibility	Students were keen on being able to access the resources whenever they wished to aid their revision/ enhance their learning.	After further analysis of the sub categories within this topic the following thematic sentences have been created: • Students value that the learning resource can be accessed in their own time and at their own pace • Students valued the visual element of this resource • The resource was an additional resource to support prior learning
Pace	Multiple students commented that they liked being able to access and observe the animations at their own pace. It was stated that this is not something that they were able to do in a clinical environment. 'You have time to observe more things and ask questions'	
Visual learning	Students said that they were able to take their time to notice things/ observe the simulated deviations.	
Additional resource	Students commented that they used additional resources/ sessions alongside the animations to help with their learning and improve clinical skills.	

3. Improvements

	Participant 1	Analyst comments
Extra resources	There were many comments about students wanting additional specific scenarios in an animated format to enhance their learning. Students also requested additional questions and answers to access whilst working through the animations.	After further analysis of the sub-categories within this topic, the following thematic sentences have been created: • Further content in a similar format is desired