African Vision and Eye Health
ISSN: (Online) 2410-1516, (Print) 2413-3183

Developing a paediatric eye movement therapy application: Expert feedback on a gamified paper prototype for South African children

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Dates:
Received: 22 July 2025
Accepted: 31 Mar. 2026
Published: 24 June 2026

How to cite this article:
Jugdeo P, Khan NE. Developing a paediatric eye movement therapy application: Expert feedback on a gamified paper prototype for South African children. Afr Vision Eye Health. 2026;85(1), a1099. https://doi.org/10.4102/aveh.v85i1.1099

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Background: Development and learning in school-going children can be influenced by the inability to perform accurate saccades and pursuits. To be able to appreciate good, clear vision with stereopsis, it is essential that both foveae are aligned towards the desired object. It is vital that the oculomotor system is healthy for this to occur. Young children with oculomotor dysfunction may benefit from timely detection and prompt initiation of eye movement therapy.

Aim: This study aimed to analyse and discuss feedback from expert reviews of an eye movement therapy paper-prototype.

Setting: The study was conducted online via Google Forms.

Methods: A comprehensive literature review of existing therapy tools was undertaken online, after which a paper-prototype for paediatric eye movement therapy was developed and shared with African field experts. The feedback from the field experts was obtained via a Google Form questionnaire.

Results: All four field experts expressed that the design was easy to understand and agreed it would be of value to paediatric eye health therapy. It was suggested that more colourful and interactive visuals can be added to boost engagement. The inclusion of time limits and adjustable difficulty to manage screen use was emphasised. Consulting early childhood educators was advised to ensure the content is in sync with the current trends and interests of the targeted age-group.

Conclusion: The paper-prototype produced in this study simulated the application's user interface and user experience before creation of the first digital prototype. The expert review indicated that the paper-prototype produced is clinically relevant and engaging. With minor modifications to its design and content, the app can serve as a useful supplement to in-office vision therapy in South Africa.

Contribution: This supplementary eye movement therapy tool will be the first to be created just for South African children with a unique and engaging therapy sequence.

Keywords: eye movements; gamified; digital; oculomotor dysfunction; paper-based.

Introduction

Optometry plays a pivotal role involving possible disorders pertaining to vision and its contribution to efficient learning. Visual efficiency includes accommodation, binocular vision and eye movements such as saccades and pursuits. In school-going children, development and learning can be significantly impacted by inefficient saccades and pursuits. Their daily learning, both in the classroom and at home requires smooth pursuits, accurate saccades and steady fixation.[1] Examples of these include tracking a ball on the playground, scanning the classroom for an object or changing fixation while copying notes from the board. It is essential that oculomotor dysfunction (OMD) is timeously detected in these children and promptly treated.

Different milestone periods in early childhood allow for the development of the various aspects of the visual system. However, not all individuals are able to fully perform complex visual skills. Previous studies show that one in four school-aged children live with undetected vision issues, as a result, these children struggle with classroom, recreational and sport activities.[1]

If smooth pursuits are impaired and cannot cope with the speed of the moving target, catch up saccades will occur, and a choppy and/or saccadic movement will be seen.[2] Saccadic eye

movements are to swiftly change the direction of both eyes to fixate on different targets when necessary. Abnormal saccades will present as a visible hypometria (undershoot) or hypermetria (overshoot) of the objects of interest. Early intervention by an optometrist is imperative because vision problems like OMD, amblyopia or uncorrected refractive error may progress into adulthood, affecting productivity at work and quality of life. Oculomotor dysfunction can occur because of a delay in development, injury to the brain or a neurological abnormality.[3] Damage to the cerebellum, brainstem and basal ganglia causes a communication disruption between the brain and the extraocular muscles. This damage can be a result of concussions or other traumatic brain injuries.[4] Various neurological conditions such as stroke, multiple sclerosis, neurodegenerative disease (Alzheimer's disease and Parkinson's disease), migraines and brain tumours affect pursuits, saccades and fixation.[3]

In children, certain conditions like attention deficit hyperactivity disorder (ADHD) can cause OMD.[5] Neuroimaging research in ADHD shows a lower volume in the frontal region, cerebellum and sensorimotor brain regions. The basal ganglia and anterior frontal cortex also show a reduction in activation.[5] Because these regions in the brain govern eye movement, such as pursuits, saccades and fixation, it is expected that these eye movements may be deficient in children with ADHD. Prematurity or trauma during birth may also compromise the development of these regions of the brain and lead to abnormal oculomotor function.[6] A detailed case history can help the optometrist gauge an understanding of the possible cause of the OMD.

Studies show that even after 3 weeks of oculomotor training, a significant improvement can be noted in eye movement.[7] This reiterates the purpose of this study. Effective oculomotor therapy requires stable binocular alignment; therefore, Binocular vision (BV) conditions such as strabismus and convergence insufficiency must be treated prior to initiating eye movement therapy. Symptoms like diplopia, headaches and visual strain may otherwise limit progress. Long periods of digital-device use (>3 h/day) are associated with reduced amplitude of accommodation, accommodative infacility and low base-out reserves, compared to individuals who limited their device usage.[8,9] In 2018, 'Gaming disorder' was added to the *International Classification of Diseases, Eleventh Revision* by the WHO.[10,11] As shown by magnetic resonance imaging (MRI) studies, cell phone and gaming addictions could alter the physical structure of the brain in such a way equivalent to drug and gambling addictions.[12] Because children of today are referred to as 'digital natives',[13] this study focused on gamification and digitisation to deliver this therapy tool. This aids in grasping and maintaining the child's attention throughout the therapy session. Although this study embarked on a digital route to eye movement therapy, it will not entirely replace in-office therapy. This will be a hybrid approach to vision therapy comprising a fixed duration of screen-time together with scheduled in-office therapy.

A review of recent studies highlighted the potential of digital and gamified technologies to enhance children's eye movement therapy and overall health. Computer-based and eye-tracking programmes improved saccades, pursuits and fixation while increasing motivation and adherence.[13,14] Gamification elements, such as rewards, streaks and adjustable difficulty.[8,15,16] Action-based games like *Fruit Ninja* and *Piano Tiles* stimulate rapid eye movements, improving visual attention and coordination.[17,18] Because most digital vision tools originate from Western contexts, there is a need for culturally adapted, accessible applications in South Africa.[19] Traditional paper-based therapies remain effective but can be cumbersome and less engaging, highlighting the value of gamifying these exercises to improve motivation, portability, and adherence. Overall, evidence supports developing culturally relevant, gamified digital tools to make oculomotor training more engaging, accessible and clinically effective for children. As mentioned, the theoretical framework included the Gamification Theory, COM-B Behaviour Change Model, and Technology Acceptance Model (TAM). These theories draw on ways to enhance engagement and effectiveness. The theory of gamification and key-health behaviour change models were used when drafting the paper design. The Gamification theory states that game-like elements increase the likelihood of people remaining motivated and enjoying learning. This is why engagement is significantly improved when rewards, scores and leaderboards are incorporated. Gamification also includes elements like points, badges and storytelling to make exercises fun.[8] The COM-B Behaviour Change Model suggests that for a behaviour to occur, three conditions must be met: capability, opportunity and motivation. It ensures that children are able to perform eye exercises, have the chance to do them, and are motivated to engage.[20] The TAM theory emphasises perceived usefulness and perceived ease of use.[21] This suggests that users are more likely to engage with an app that they find valuable and simple to understand and use.[22]

Hence, the research question of this study is: 'How can a gamified supplementary eye movement therapy application be designed on paper that will serve as a blueprint for future development of digital applications?'

The present study developed a paper-based prototype of a gamified eye movement therapy application. The prototype was evaluated by South African and broader African experts in binocular and paediatric vision. The article reports and discusses expert feedback on the usability of the paper-based prototype. This tool will be locally designed with a South African 'flavour'. The inclusion of culturally relevant content creates a sense of familiarity among users, thus maintaining stronger engagement. This addresses a significant gap in South African paediatric eye health therapy because it combines existing therapy methods with child-friendly digital interaction. There is no application with this concept available currently.

Research methods and design

This study employed a qualitative content analysis study design with expert review validation to develop and assess the usability of a paper-based prototype of a paediatric eye

movement therapy application, specifically intended for South African children. The article reports and discusses expert feedback on the usability of the paper-based prototype.

Literature review and prototype development

A comprehensive literature review was conducted using databases such as PubMed, Scopus and authoritative clinical websites like the World Health Organization and the Cleveland Clinic. The review aimed to identify existing digital and non-digital eye movement therapy tools, evidence-based treatment approaches for OMD, and key components of efficient therapy design, especially those incorporating gamification and child-centred engagement strategies.

Based on the insights obtained from the literature review and theoretical framework, a paper prototype of the therapy application was designed. The prototype included a sequence of interactive therapy exercises (such as visual tracing and tracking) with three culturally relevant visual storylines. Locally inspired visuals, including South African animals, signs and symbols, were incorporated. The concepts described previously in the theoretical framework were used to ground the paper-prototype. For the development of the paediatric eye movement therapy paper prototype, the Department of Basic Education Rainbow workbook series[23] was used to gain inspiration on eye-catching targets and South African signs and symbols. An internet search for relevant images was also performed. The visuals incorporated into the prototype featured local objects and symbols, animals and everyday scenes. Creating a sense of cultural relevance was intended because this has been shown to enhance motivation, understanding and memory in educational settings. Based on these symbols and a comprehensive literature search, three interactive stories and six practice exercises were created, forming an engaging therapy sequence. Exercises within the application included modified versions of visual tracing and visual tracking. It is intended that the paper prototype will be converted to a digital application in a future study. Although this therapy tool is not intended for use as a standalone treatment for OMD, it may serve as a fun supplement in a structured oculo-motor therapy programme. The Therapy application should be recommended only after a diagnosis of OMD is made by the child's optometrist. Home-based therapy on a digital platform will allow the optometrist to track therapy progress and provide live feedback, enhancing efficacy of the programme.

Creating the therapy exercises using the national curriculum-based content as inspiration helps the software serve a dual-purpose: giving vision therapy and supporting early learning. This approach reinforces the close connection between vision and learning and responds to the need for accessible, affordable and comprehensive vision care in South Africa's school health system. When children establish a sense of familiarity with the local symbols and games, it significantly enhances the chances of sustained engagement and improved efficacy. This is also an opportunity for South African children to improve their general knowledge of our country.

Expert review process

A purposive sampling approach was used to select professionals with expertise in paediatrics and binocular vision, ensuring clinical and educationally relevant feedback. Six experts were invited to participate however, only four accepted to participate, resulting in a response rate of 66.7%. These experts were chosen from different provinces in South Africa and other African countries to capture diverse perspectives. All participants are qualified optometrists who serve as lecturers in binocular or paediatric vision and have experience in both clinical practice and academic training. The final paper-prototype was shared with the four field experts to gain user experience feedback and gauge their insight on the therapeutic value of the design.

Data collection via Google Forms

An online questionnaire was designed using Google Forms to gather expert feedback. The form was distributed electronically, and experts were given 2-weeks to provide a response. The Google Form comprised three parts. Part one of the Google Form included three forced-choice (yes or no) questions was intentionally designed to serve as a *baseline measure* of the expert's basic understanding, perceived value, and usability of the prototype. These questions were not meant to generate in-depth insights, but rather to add to the qualitative feedback section that followed.

Part two of the Google Form described three open-ended questions. The first open-ended question, 'What improvements to the Paper-Based Design would you suggest?' explored design enhancement and usability, focusing on layout, visual presentation, task clarity and engagement features of the prototype. The second open-ended question was, 'As a Paediatric Binocular Vision expert, what do you think is important for the researcher to consider when formulating a therapy plan based on digital games?' This question investigated clinical considerations for digital therapy design, including safety, efficacy, age-appropriateness and the use of evidence-based oculomotor training. And the third question, 'What key points can you suggest ensuring that the project is designed efficiently to achieve the best possible therapeutic outcome?', targeted key elements for successful application and achieving desired results, such as tracking mechanisms, task progression, user engagement and alignment with therapeutic goals. The responses from the field experts are presented in Table 1.

The questions in part one and two in the Google Form have not been based on a specific questionnaire; however, it is a compilation of questions adapted from paper prototyping articles available online: Principles of Questionnaire Construction,[18] Interface design survey questions,[24] A practical guide to usability questionnaires that evaluate clinicians' perceptions of health information technology.[19]

The forced-choice (yes or no) questions in Part One were used to provide baseline information on experts' understanding of the prototype. These responses were not analysed statistically

TABLE 1: Showing the experts responses to part 2 of the questionnaire.

Expert	What improvements to the paper-based design would you suggest?	As a paediatric and/or binocular vision expert what do you think is important for the researcher to consider when formulating a therapy plan based on digital games?	What key points can you suggest ensuring that the project is designed efficiently to achieve the best possible therapeutic outcome?
Expert 1	The paper-based design is good, clear and easy to understand, even to the parents	Consider the child's excitement when taking the test for the first time and make sure to maximise it while also considering screen time and tiring the child. What is also important is understanding the cause of the deficiency of the eye movement. Beginning with simple exercises and progressing to more complex ones improve therapy efficacy as the child will learn through the exercises.	Define the daily performance frequency, such as attempting exercise three times a day. Time the exercise so that the allotted time to complete the task continuously decreases, enabling the child to work more efficiently, thus improving the status of the eye movements.
Expert 2	Kindly add something more interesting for the patients in terms of designs, try to also use some stories more relevant for kids, for example, *Cocomelon*? and get expert from kindergarten teachers	It must be timed game to avoid spending more time on game inducing myopia, it must be also timed to give record of time patient spent on digital game.	It should be easy to understand for kids, interesting to kids and easy to monitor in terms of time spent on digital device.
Expert 3	I wish I had access to the electronic version, even though the paper design is provided	They should be interesting to the paediatric patients.	Pre-testing of project on the paediatric population.
Expert 4	The design looks ok to me currently	I think it is very good the designer factored in a short time of testing with restrictions within a day to eliminate inducing myopia from constant near work demand on the eye. I think the designer as part of using the tool should factor in a fixed near distant. Designers should also consider measuring and evaluating the accommodative and vergence parameters, not just pursuit and saccadic movements over the period of therapy.	Maintain a fixed near distant for therapy, use very good graphics for the final design to eliminate straining, use valid questionnaires to evaluate symptoms over therapy period.

but were used to support the qualitative findings from Part Two. The open-ended responses were analysed thematically. Common ideas were grouped into key themes that could be used to further improve the existing design idea.

The short user experience questionnaire[25] was the third part of the Google Form. This was designed to assess the usability and engagement of the paper-based prototype (see Figure 1). A semantic-differential scale was used, for example, *obstructive* versus *supportive*, *boring* versus *exciting*. Experts rate the item on a scale between these opposites.

The circles represent a numerical scale, from 1 to 7. The leftmost circle corresponds to the first adjective (e.g. *obstructive*). The rightmost circle corresponds to the second adjective (e.g. *supportive*). Respondents select the circle that best represents their perception.

Obstructive	0 0 0 0 0 0 0	Supportive	1
Complicated	0 0 0 0 0 0 0	Easy	2
Inefficient	0 0 0 0 0 0 0	Efficient	3
Clear	0 0 0 0 0 0 0	Confusing	4
Boring	0 0 0 0 0 0 0	Exiting	5
Not intresting	0 0 0 0 0 0 0	Interesting	6
Conventional	0 0 0 0 0 0 0	Inventive	7

Source: Schrepp M, Hinderks A, Thomaschewski J. Design and evaluation of a short version of the User Experience Questionnaire (UEQ-S). Int J Interact Multimed Artif Intell. 2017;4(6):103–108. https://doi.org/10.9781/ijimai.2017.09.001

FIGURE 1: The short user experience questionnaire.

Data analysis

Responses from the forced choice questions and open-ended questions (part one and two) were recorded and entered onto Microsoft Excel for descriptive analysis. Qualitative responses from open-ended questions were analysed thematically. Similar responses from the experts were categorised and summarised. Results from the short user experience questionnaire (part three) were sent to a statistician and were numerically analysed.

Ethical considerations

Ethical clearance to conduct this study was obtained from the University of Kwazulu-Natal and Biomedical Research Ethics Committee (No.BREC/00007723/2024).

Results

Results of Part One of the Google Form revealed that all experts were able to understand the concept of the design and thought that it was easily understandable. All agreed that this supplementary therapy tool will be a valuable contribution to South African Paediatric eye health therapy. Valuable insights on improving the current design were shared by the experts.

The results from Part Two of the questionnaire are depicted in Table 1.

The four themes identified from the responses were as follows:

- Cause of the eye movement disorder.
- Accommodation and binocular vision.
- Screen-time and myopia control.
- Children's contemporary interests.

The first theme that emerged from the responses emphasised the importance of understanding the underlying cause of the eye movement disorder. The purpose of smooth pursuits is to keep slow motion targets stable on each fovea.

The second theme highlighted was accommodative and binocular vision. It was suggested that accommodative and vergence parameters are also measured and evaluated over the period of eye movement therapy.

Screen-time and myopia control were the third theme that emerged from the responses. Three out of the four experts

emphasised the importance of monitoring the child's screen time. In the current therapy tool's design, the time restriction will serve as a control of the time spent on the application. This time limit will shut down the application, and content may only be accessed after 24 h.

Incorporating children's contemporary interests was the fourth theme identified from the expert feedback. One participant suggested getting expertise from kindergarten teachers in terms of the current interests of primary school children, such as *Cocomelon*. This suggestion is consistent with the concepts in the COM-B model.

Results of part three, the short user experience questionnaire, indicate that participants found the paper-based prototype generally positive in usability and design. Participants rated it as easy (75%), supportive (50%), efficient (50%) and clear (50%), suggesting it was simple to navigate and well-structured. Ratings for interest, excitement and inventiveness were moderate.

Discussion

The discussion incorporates four subheadings, which are the themes that were mentioned in the results.

Cause of the eye movement disorder

Saccadic intrusions (involuntary saccades) and impaired initiation of saccades and saccadic oscillation may occur in conditions like Parkinson's, MS and cerebellar dysfunctions. These movements present as jerky, fluttery, rhythmic and arrhythmic oscillations.[26]

Children with OMD quickly develop compensatory actions to overcome difficulty with pursuits, saccades and fixation. They may use their finger or pencil to point along lines or adopt a head tilt to assist them overcome the effects of these eye movement disorders. It is therefore important to identify the cause of the OMD through a comprehensive case history from both the parent or guardian and the child. Noting these abnormal eye movements and behavioural cues will assist the optometrist in a timeous diagnosis.

Accommodation and binocular vision

It is well-known that prompt detection of binocular vision disorders is essential. Development and learning are negatively impacted in children when these disorders go undetected. As a result, social and academic success are hindered. It is imperative that any binocular vision disorders are treated prior to initiating eye movement therapy, as untreated conditions may result in diplopia, unstable fixation and compromised smooth pursuits and saccades.

The power of the accommodative system is well known to optometrists. The stamina and strength of this system can be easily overworked when excessive close-up work is done with poor visual hygiene. As a result of our excessive digital demands nowadays, accommodative insufficiency quite commonly shows up in our chairs. Testing usually reveals low accommodative clinical findings, including reduced Visual acuity (VA), intermittent blur and small amounts of against-the-rule astigmatism.[27] It is crucial to promptly recognise and treat these signs in addition to the symptoms, such as strain, headaches and tiredness.

Besides the accommodative system, we also note excessive strain on the binocular vision system. Development of BV starts in the brain, and there is valid neurologic evidence that too much screen-time stimulates visual processing more intensely than even the sensory processing systems, this in turn negatively impacts healthy binocular vision development.[4] Kattouf stated that both convergence excess (high esophoria at near) and convergence insufficiency (high exophoria at near) are commonly seen in her practice because of uncontrolled screen-time among the youth of today. Besides the time spent focusing close-up, it is also the actual distance of the device itself that influences the onset of these BV disorders.

In an Optometry review article by Darko-Takyi and Ebrahim Khan et al. from the University of KwaZulu-Natal,[28] it was stated that patients do not always present with only one specific binocular vision or accommodative disorder. Because both these systems are closely interlinked, a vergence anomaly may often be secondary to an accommodative anomaly and vice versa. In addition to the range of tests necessary to make a diagnosis for these non-strabismic conditions, a comprehensive case history would be a clue to revealing the cause of the symptoms experienced.[28]

Clinical studies reveal that the close viewing distance of handheld digital devices becomes even closer with prolonged use.[4] The chief complaint of parents who bring their young children in for an eye examination is the observation of how closely the child views a cell phone or tablet. The closer the viewing distance – accompanied by overuse – the more likely an increase in diagnoses of accommodative and binocular vision issues and the visual symptoms that accompany them, says Dr Kattouf.[4] These binocular vision aspects are to be monitored by the optometrist at the scheduled follow-up sessions. Therapy should only be recommended once the binocular vision and accommodative systems have been evaluated for any BV disorders. If present, these should be treated first. Hence, accommodative and binocular vision parameters must be measured and evaluated in children throughout the therapy programme.

Screen-time and myopia control

It is well established that myopia progression is linked to an increase in digital device use and screen-time. This has been taken into consideration when designing the paper-prototype. Based on the commonly advised 20-20-20 rule, the therapy sessions within the application are limited to 20 min to minimise screen exposure while maximising therapy outcomes. It is also advisable that the parent or legal guardian

is supervising the child's screen time daily to ensure that good visual hygiene is maintained.

Although excessive screen time is known to be harmful in young children, the type and quality of content also influence outcomes. Prolonged passive use, such as aimless scrolling or extended cartoon viewing, may contribute to myopia development and progression. Interactive screen time that is educational and stimulates critical thinking can benefit children[4,10,29] The paper prototype was designed with this in mind. A creative, interactive method was used to deliver the eye movement therapy exercises.

Children's contemporary interests

The COM-B key-behaviour health change model helps understand the aspects influencing health-related behaviour change. It suggests that behaviour is a product of the interaction of the following: capability, opportunity and motivation.[30] If children are tasked with something within their capability and understanding, they are more likely to interact well with it.[30] Their motivation to persist in the completion of therapy sessions will be sustained if they are able to relate to the ideas, themes and images within the game, such as the currently popular '*Cocomelon*'. Perceived usefulness: 'The degree to which a person believes that using a particular system would enhance their performance'.[31] This involves how much children or teachers believe in the technology. If a distinct benefit is noted, participants are more likely to engage with the tool. In the context of this study, if children find the interface challenging to navigate or do not recognise the therapeutic effect, this will discourage them from engaging with it – even if the game design is perfectly designed. This idea comes from the TAM within the Gamification theory.[8]

The design decisions were guided by gamification and behaviour change theory. The main therapeutic goals were to improve fixation, smooth pursuits and saccadic accuracy through structured exercises. Because this research is innovative, the proposed therapy sequence within the application is to be further tested and validated in the follow-up study.

The games will begin with simple exercises and progress to more complex ones. This will improve therapy efficacy as the child will be required to overcome a task to advance to the next. This will result in a sustained advancement in the eye movement skills for participants. This therapy structure will ensure that pursuits and saccades are efficiently trained with simple exercises before presenting more challenging ones. In this way, children are less likely to become agitated or overwhelmed by very difficult activities. The gradual, step-by-step reinforcement of these skills will encourage a maintained engagement with the therapy tool and sustained improvement in pursuits, saccades and fixation.

Feedback on the short user experience feedback questionnaire was positive, particularly regarding simplicity of understanding and use, clarity and supportiveness of the design. Most participants felt that the tool was easy to use and well-structured. However, in the engagement-related categories lower scores were obtained. This suggests that the design will benefit from an enhanced creative and emotional appeal. Improving visual and gamification elements, introducing playful features, or incorporating popular children's media may help increase excitement and engagement. The design of the application has been developed only to be used as a supplement to an eye movement therapy plan. It may not be used to diagnose the cause of the disorder or be used in isolation. It may only be recommended to a patient once the aetiology of the eye movement disorder is determined by the Optometrist at the comprehensive eye test, and the treatment of the underlying disorder is being managed.

Limitations

One limitation of this study is the small sample size of experts. A larger expert panel would have allowed for more diverse feedback and valuable critique. It may have also been beneficial to hold a physical focus group meeting with the expert panel, as this would allow for more constructive feedback through actual conversations rather than via a survey.

Conclusion

This feedback obtained by the field experts will be considered in the next phase of the application's development, which involves creating the digital prototype and conducting pilot testing with children under professional supervision. All four field experts understood the application design and agreed it would be a valuable contribution to paediatric eye health therapy. However, it was emphasised that this application (as the authors intended for it), should only serve as a supplement to a formal therapy plan, not for diagnosis or as a standalone treatment. Therapy should be recommended only after a comprehensive eye exam to determine the cause of the eye movement disorder. It was also advised that binocular vision, accommodative, and vergence parameters are evaluated and monitored throughout therapy, with any binocular vision disorders treated first. The design has been guided by principles of the Gamification Theory and behaviour change models (such as COM-B and the TAM). This was used to make the design more engaging for school-aged children. The local theme of this application is intended to improve both compliance and therapeutic outcomes for South African children with OMD.

Acknowledgements

This article is based on research originally conducted as part of Priyanka Jugdeo's master's thesis titled 'A paper design of a digital paediatric eye movement therapy application for South Africa', submitted to the Department of Optometry,

University of KwaZulu-Natal in 2025. The thesis was supervised by Naimah Ebrahim Khan. The thesis was reworked, revised and adapted into a journal article for publication. The original thesis is currently unpublished and was not publicly available online at the time of publishing this article.

Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

CRediT authorship contribution

Priyanka Jugdeo: Writing – original draft, Writing – review & editing. Naimah Ebrahim Khan: Funding acquisition, Supervision. All authors reviewed the article, contributed to the discussion of results, approved the final version for submission and publication, and take responsibility for the integrity of its findings.

Funding information

The authors received no financial support for the research, authorship and/or publication of this article.

Data availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

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