

You Are What You Eat: Development and Evaluation of a Two-Dimensional (2D) Frame-by-Frame Vector Animation for Nutrition Awareness

Nurin Amanina Anuar¹, Hamzah Asyrani Sulaiman^{2*}, Che Ku Nuraini Che Ku Mohd³,
Mohamad Lutfi Dolhalit⁴, Nur Saadah Mohd Shapri⁵

^{1,2,3,4}*Faculty of Information and Communication Technology, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia.*

⁵*Faculty of Informatics and Computing, Universiti Sultan Zainal Abidin, 21300 Kuala Nerus, Terengganu, Malaysia.*

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ABSTRACT

Unhealthy dietary habits remain a significant public health challenge in Malaysia, contributing to the rising prevalence of non-communicable diseases. This study presents the development and evaluation of a two-dimensional (2D) frame-by-frame vector animation titled 'You Are What You Eat', designed to promote nutrition awareness among the general public. The animation was developed following the Animation Pipeline methodology comprising pre-production, production, and post-production phases using Adobe Animate, Adobe Illustrator, and Adobe Premiere Pro. The animated short film employs narrative storytelling to communicate the consequences of poor dietary choices and the benefits of balanced nutrition. Evaluation was conducted through user testing involving three subject matter experts and 18 target users from diverse backgrounds. Both expert and user evaluations yielded consistently positive results across content quality, technical execution, narrative effectiveness, and flexibility dimensions. Findings suggest that 2D frame-by-frame vector animation is an effective, accessible, and engaging medium for health education and nutrition communication. These findings have meaningful implications for future digital public health campaigns. Future work should explore larger-scale evaluations, culturally representative character design, and the integration of interactive elements to further enhance knowledge acquisition and behavioural intention outcomes.

1. INTRODUCTION

Public health challenges related to nutrition and dietary habits continue to escalate globally, with Malaysia experiencing an alarming increase in the prevalence of non-communicable diseases (NCDs) such as obesity, type 2 diabetes, and cardiovascular disease. The National Health and Morbidity Survey (NHMS) 2023

^{2*}Corresponding author. *E-mail address:* asyrani@utem.edu.my
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reported a diabetes prevalence of 15.6% among Malaysian adults, with hypertension at 29.2%, hypercholesterolaemia at 33.3%, and obesity at 21.8% (Institute for Public Health, 2023). These figures underscore a persistent and deepening public health crisis driven substantially by unhealthy dietary practices. According to Mansor and Harun (2014), Malaysians demonstrate a significant lack of awareness regarding healthy dietary practices, a gap that necessitates innovative and accessible health communication strategies. Conventional approaches to health education, relying primarily on printed materials and static media, have proven insufficient in sustaining public engagement and fostering lasting attitudinal change (Mayer et al., 2005; Tuong et al., 2014).

Animation, as a multimedia communication tool, has gained considerable traction in educational and public health contexts. Its unique capacity to synthesise visual storytelling, audio narration, and motion graphics enables complex concepts to be communicated in an engaging and memorable manner that transcends age, literacy levels, and educational backgrounds (Wright, 2013). Mayer's (2001) Cognitive Theory of Multimedia Learning (CTML) provides a robust theoretical basis for this approach, positing that learning is enhanced when information is presented through both visual and auditory channels simultaneously, enabling deeper cognitive processing and schema construction. Animated content has been shown to enhance comprehension, emotional engagement, and knowledge retention more effectively than static text-based media (Mayer & Moreno, 2002; Wong et al., 2019). A systematic review by Moe-Byrne et al. (2022) confirmed that video animations produced predominantly positive effects on patient knowledge, attitudes, and behavioural intentions compared to other information delivery formats.

Among the various forms of animation, two-dimensional (2D) vector animation has emerged as a particularly viable option for educational content production due to its cost-effectiveness, scalability, and compatibility with a wide range of digital platforms. Unlike raster-based graphics, vector animations maintain resolution integrity regardless of display size, making them suitable for dissemination across smartphones, tablets, and desktop computers. The frame-by-frame animation technique, in particular, affords animators precise control over each movement and expression, enabling the creation of fluid and expressive character-driven narratives (Wright, 2013).

This paper presents the development and evaluation of *You Are What You Eat*, a short 2D vector animation designed to address the identified gap in nutrition awareness among the Malaysian public. The animation employs a relatable narrative storyline featuring characters navigating the consequences of unhealthy dietary habits and gradually adopting a balanced diet following medical consultation. The work was guided by three primary objectives: (i) to investigate the effectiveness of 2D animation as a medium for health information delivery; (ii) to develop a 2D animation that promotes healthy and balanced dietary practices; and (iii) to assess user acceptance and awareness outcomes following exposure to the animation.

The remainder of this paper is structured as follows: Section 2 presents a review of relevant literature on animation in health communication and existing systems. Section 3 outlines the methodology underpinning the animation's development. Section 4 describes the implementation process, Section 5 presents the evaluation findings and discussion, and Section 6 concludes with limitations and recommendations for future work.

2. LITERATURE REVIEW

2.1 Animation as a medium for health communication

Animation as a pedagogical and communicative tool has a well-documented history of effectiveness across diverse audiences and subject domains. Wright (2013) argues that animation fundamentally differs from other media forms in its ability to compress time, abstract complex processes, and construct narrative worlds that are simultaneously fantastical and relatable. These properties render animation uniquely suited to health communication, where abstract physiological concepts must be made tangible and attitudinal

change must be motivated through emotional engagement rather than mere information transfer. A meta-analysis of 21 studies by Feeley et al. (2023) confirmed an overall positive effect of animated videos on health learning ($d = 0.35$), with stronger effects observed in patient-facing contexts, while Knapp et al. (2022) extended these findings across practitioner and student populations in a systematic review of 13 trials, further reinforcing the broad applicability of animation-based health education.

Mayer et al. (2005) conducted seminal research comparing the effectiveness of static annotated illustrations versus narrated animations in multimedia instruction, concluding that learners who engaged with narrated animated content demonstrated superior recall and transfer of knowledge compared to those exposed to static materials alone. This finding aligns with the Cognitive Theory of Multimedia Learning (Mayer, 2001), which is grounded in three core assumptions: the dual-channel assumption, which holds that humans process visual and auditory information through separate channels; the limited-capacity assumption, recognising finite working memory; and the active-processing assumption, which posits that meaningful learning requires active cognitive engagement including selecting, organising, and integrating information (Mayer & Moreno, 2002). The CTML provides the primary theoretical foundation for the present study, justifying the use of narrated animation as a superior modality for health information delivery.

In the context of public health, animated content has demonstrated measurable efficacy in modifying knowledge, attitudes, and behavioural intentions across a range of health topics. A systematic review by Moe-Byrne et al. (2022), encompassing 38 controlled studies, found that video animations produced predominantly positive effects on patient knowledge and attitudes compared to other delivery formats such as printed materials and verbal consultations. A more recent review by Hansen et al. (2024), covering 15 randomised and quasi-randomised studies, further corroborated these findings, reporting that the majority of included studies demonstrated a significant positive impact of animation videos on health information recall across diverse clinical settings. Tuong et al. (2014) similarly reported that video-based educational interventions were effective in modifying health behaviours, particularly when combined with narrative and personalised messaging. Within the Southeast Asian context, Aisah et al. (2022) demonstrated that animated educational videos significantly improved anemia prevention knowledge among female adolescents in Indonesia, supporting the region-specific efficacy of this medium. At scale, Vandormael et al. (2021) demonstrated in a large-scale randomised controlled trial involving 15,163 participants across five countries that short animated videos distributed via social media significantly improved health prevention knowledge, highlighting the potential of digital animation dissemination for broad public health communication. Okpara et al. (2021) further confirmed that animated cartoon content on digital platforms significantly predicted knowledge gain and health behaviour change among social media users, reinforcing the utility of animation for large-scale digital health campaigns. These findings collectively support the premise that animation-based health communication can serve as a powerful and scalable medium for promoting dietary awareness.

Ahmad and Yousef (2017) examined the use of animated cartoons in brand awareness campaigns in Malaysia and Jordan, finding that animated advertising significantly outperformed non-animated formats in terms of audience recall and attitudinal change. While the commercial framing of this study differs from health education contexts, the underlying cognitive mechanisms—enhanced attention, emotional engagement, and narrative transportation—are analogous. Particularly relevant to the Malaysian context is research by Mohamad et al. (2023), who investigated public awareness of the 'Malaysian Healthy Plate' dietary concept. Their study found that despite government health promotion campaigns, a substantial proportion of Malaysians remained unaware of evidence-based dietary guidelines, underscoring a persistent disconnect between information availability and effective communication.

2.2 Narrative Transportation and Health Behaviour Change

The effectiveness of narrative-based health communication can be understood through Narrative Transportation Theory (Green & Brock, 2000), which posits that individuals who become cognitively and emotionally absorbed in a story are more likely to exhibit story-consistent changes in their real-world attitudes and beliefs. This theory provides a critical framework for understanding why the storytelling approach employed in *You Are What You Eat* may be more effective than traditional didactic health messaging.

Murphy et al. (2013) empirically tested the effectiveness of narrative versus non-narrative health communication formats, finding that narrative formats were more effective in increasing health-related knowledge and attitudes. Importantly, their study demonstrated that transportation, identification with characters, and emotional engagement each independently contributed to shifts in knowledge, attitudes, and behavioural intentions. These findings are particularly relevant to the present work, which deliberately employs relatable characters and an emotionally engaging storyline to encourage viewers to reflect on their own dietary practices.

The Theory of Planned Behaviour (TPB) (Ajzen, 1991) further contextualises these findings within a broader behavioural framework. The TPB posits that behavioural intention—the most proximal determinant of actual behaviour—is shaped by three factors: attitudes toward the behaviour, subjective norms, and perceived behavioural control. In the context of dietary modification, animated narrative interventions may positively influence all three determinants by shifting attitudes through emotional engagement, modelling social norms through character behaviour, and enhancing perceived control through practical dietary guidance embedded in the narrative (McDermott et al., 2015). The measurement of behavioural intention in the present study's evaluation design is therefore theoretically grounded in established models of health behaviour change.

2.3 2D vector animation: Technical and pedagogical dimensions

Two-dimensional vector animation represents a distinct category of digital animation characterised by the mathematical representation of graphical elements as geometric shapes defined by paths, curves, and nodes rather than pixel arrays. This architectural distinction confers several pedagogical advantages. Vector graphics scale seamlessly across display resolutions, ensuring consistent visual quality on devices ranging from smartphones to large-format screens. Research on educational animation design has consistently demonstrated that simplified, clean visual designs—such as those typical of 2D vector aesthetics—reduce extraneous cognitive load by minimising irrelevant visual detail, thereby allowing learners to direct cognitive resources toward content comprehension rather than visual decoding (Wong et al., 2019). This aligns with Mayer's Coherence Principle, which holds that learning improves when extraneous material is excluded from multimedia presentations (Mayer, 2001).

The frame-by-frame animation technique, employed in the present work, involves the sequential creation of individual frames to simulate motion, analogous to traditional hand-drawn cel animation. Unlike rigging-based approaches, which automate movement through skeletal structures, frame-by-frame animation grants the animator complete expressive control over each moment of action, enabling nuanced and naturalistic character performances. While this technique is more labour-intensive, the resultant animation quality—particularly in terms of character expressiveness and movement fluidity—more effectively supports narrative engagement and emotional resonance, both of which are important to health communication effectiveness.

Adobe Animate, the primary production tool employed in this project, provides a comprehensive environment for frame-by-frame vector animation, supporting timeline-based workflow, symbol reusability, and multi-platform export. Its integration with Adobe Illustrator facilitates efficient asset creation and vector graphic refinement, while Adobe Premiere Pro enables professional-grade audio-visual

assembly, colour correction, subtitle integration, and final rendering. This Adobe Creative Cloud workflow represents an industry-standard pipeline for short-form animated content production.

2.4 Existing nutrition-focused animation systems

Several existing animated products address nutrition education, though each presents distinct limitations that the present work seeks to address. The CGI 3D Animated Short Film *Eat Your Veggies*, produced by TheCGBros, employs high-quality three-dimensional computer-generated imagery to depict a child's imaginative resistance to vegetable consumption. While technically accomplished and cinematically engaging, the film prioritises entertainment over educational content; it contains no direct nutritional information, dietary guidance, or structured health messaging. Its target audience is further limited to children and their parents, precluding broader public health applications.

MyPlate Match, an interactive 2D animation developed by the Dairy Council of California, offers a more explicitly educational approach, presenting food group concepts through drag-and-drop interactivity. However, the product's narrow scope—targeting children under the age of 12 for classroom use—limits its applicability as a general public health communication tool. Additionally, the absence of audio narration and the simplistic visual design reduce its effectiveness for older learners who may require more substantive informational content and greater visual sophistication.

Beyond these existing products, recent scholarly work has provided further precedents for animation-based nutrition education. Silva et al. (2023) developed and validated a series of animated videos based on food processing classification for adult audiences in Brazil, demonstrating high content validity ($CVI \geq 0.96$) across both content specialist and target user evaluations. This work provides a methodological reference for the development approach employed in the present study, affirming that animation grounded in established multimedia learning theory can effectively communicate complex nutritional content to diverse general public audiences.

Table 1 presents a comparative analysis of these existing systems against the present work, illustrating how *You Are What You Eat* addresses identified gaps through its combination of narrative storytelling, comprehensive nutritional content, multi-age audience targeting, professional audio narration, and subtitle accessibility.

Table 1. Comparative analysis of existing nutrition animation systems

Dimension	<i>Eat Your Veggies</i> (CGI)	MyPlate Match	<i>You Are What You Eat</i> (present work)
Animation Style	3D CGI	2D Interactive	2D Frame-by-Frame Vector
Interactivity	Non-interactive	Interactive (drag-and-drop)	Non-interactive narrative
Target Audience	Children & parents (< 12 yrs)	Children (< 12 yrs)	General public (all ages)
Nutritional Content	None	Basic food groups	Balanced diet, food groups, disease risks, portion guidance
Audio Narration	Background music only	None	Full narrative voice-over with subtitles
Key Strength	High entertainment value	Educational food group interactivity	Narrative health education with broad accessibility

Source: *Eat Your Veggies*, MyPlate Match and *You Are What You Eat*

3. METHODOLOGY

3.1 Animation pipeline framework

The development of *You Are What You Eat* was guided by the Animation Pipeline, a three-phase production framework widely adopted in professional animation contexts (Wright, 2013). This methodology systematically structures the creative and technical processes of animation production into pre-production, production, and post-production stages, ensuring coherent narrative development, consistent visual quality, and efficient resource utilisation.

3.2 Pre-production phase

The pre-production phase commenced with narrative conceptualisation, wherein the storyline was developed based on real-world dietary health concerns in Malaysia, particularly the widespread consumption of high-sugar, high-fat foods and the resultant health consequences. A content verification interview was conducted with a student from Universiti Tun Hussein Onn Malaysia to validate the relevance and comprehensibility of the proposed content prior to production commencement.

Character design was subsequently undertaken using Adobe Illustrator, wherein four primary characters were created: Hakim (protagonist), Shah (supporting character), The Doctor (authority figure delivering nutritional guidance), and a Waiter (incidental character contextualising the restaurant setting). Each character was designed with clean vector aesthetics, culturally neutral features, and distinct visual identifiers to facilitate audience identification and narrative clarity.

A comprehensive storyboard was developed, decomposing the narrative into twelve sequential scenes progressing from Hakim's sedentary screen-viewing lifestyle, through a restaurant episode illustrating poor dietary choices, to a medical consultation culminating in nutritional guidance and attitudinal reflection. The storyboard served as the production blueprint, specifying camera framing, character positioning, voice-over content, and audio requirements for each scene.

3.3 Production phase

Animation production was executed in Adobe Animate using the frame-by-frame vector technique. Character and background assets, initially developed in Adobe Illustrator, were imported into Adobe Animate as editable vector objects and animated frame-by-frame along the software's timeline. This approach enabled precise control over character expressions and movements, supporting the naturalistic performances required for effective narrative communication.

The production phase required approximately fourteen weeks, encompassing character development (two weeks), scene animation (five-and-a-half weeks for forty scenes), audio integration (one week), and final compilation (one week). Audio production involved recording voice-over narration using a mobile device and sourcing copyright-free background music from online repositories. The narration script was written to maintain an accessible, conversational tone appropriate for general public audiences.

3.4 Post-production phase

Post-production was conducted in Adobe Premiere Pro, wherein individual animated scenes were sequenced, audio synchronisation was refined, subtitles were integrated using the software's text tools, and the final composition was exported in MP4 format for multi-platform compatibility. The resulting animation has a runtime of approximately three minutes, determined through preliminary user research to represent the optimal duration for sustaining viewer engagement without inducing information fatigue. Fig. 1 and Fig. 2 show the process of the animation.

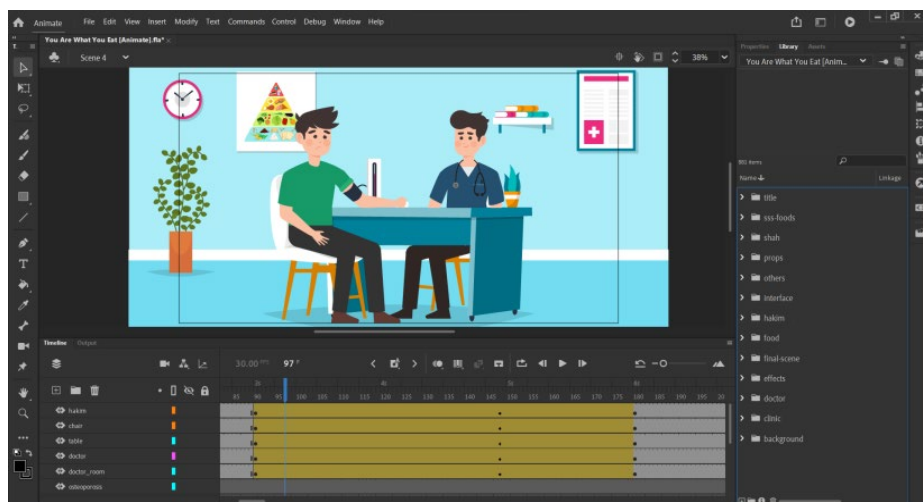


Fig. 1. Animation Production for animated video

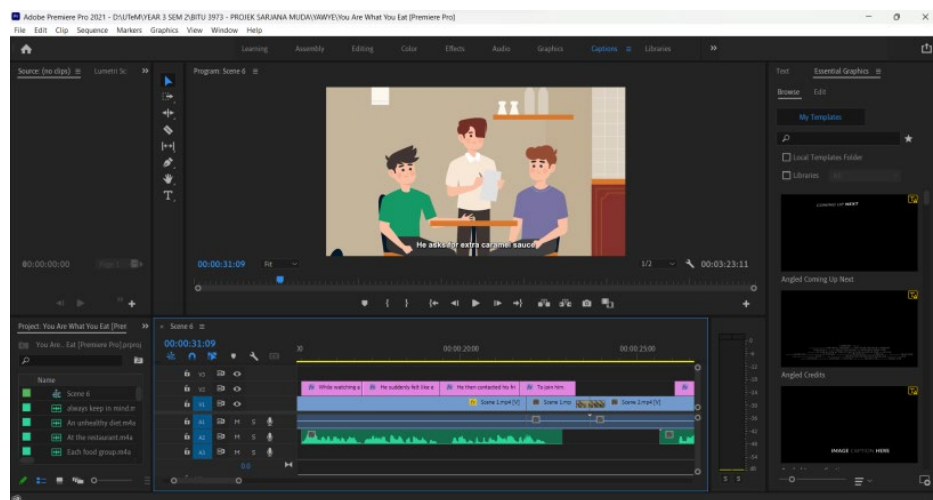


Fig. 2. Audio Production

3.5 Evaluation design

A two-group evaluation design was employed. Three subject matter experts—comprising one practising nutritionist from a community pharmacy setting and two multimedia technology lecturers from Universiti Teknikal Malaysia Melaka (UTeM)—assessed the animation across four dimensions: Content, Technical Quality, Effectiveness, and Flexibility. Each dimension was rated on a four-point Likert scale ranging from Poor (1) to Excellent (4).

The target user evaluation involved 18 members of the general public, aged 18–44 years, representing employed, unemployed, and student demographics. This sample size is consistent with a purposive pilot evaluation design, which prioritises quality of feedback over statistical generalisability; as such, the findings should be interpreted as indicative of user perceptions rather than representative of the broader Malaysian public. All evaluations were conducted through self-administered questionnaires distributed via

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Google Forms following independent viewing of the animation. Respondents completed a total of 13 evaluation items across content, effectiveness, and flexibility dimensions using a four-point agreement scale (Strongly Disagree to Strongly Agree). Of the 234 total possible responses (18 respondents $\times$ 13 items), 203 (86.8%) fell in the Strongly Agree category, with the remainder distributed across Agree and a single instance of Strongly Disagree. This distribution confirms the overall positive reception of the animation while also highlighting the need for future evaluations using larger, more representative samples.

4. RESULTS AND DISCUSSION

4.1 Subject matter expert evaluation

Expert evaluation findings are summarised in Table 2. Across all four assessment dimensions, the animation received exclusively Good (3) or Excellent (4) ratings, with no Poor or Average ratings recorded for any item except the character design assessment, which returned an equal distribution across Average, Good, and Excellent (33.3% each), indicating acknowledged variability in character quality among evaluators.

Table 2. Summary of subject matter expert evaluation results

Dimension	Item	Mode Rating	% at Mode
Content	Content delivery	Good (3)	100%
Content	Content understanding	Excellent (4)	66.7%
Technical	Narrator intonation and clarity	Excellent (4)	100%
Technical	Element size and positioning	Excellent (4)	66.7%
Effectiveness	Storytelling effectiveness	Excellent (4)	100%
Effectiveness	Educational tool effectiveness	Excellent (4)	66.7%
Flexibility	Content appropriateness for healthy eating education	Excellent (4)	66.7%

Regarding content quality, all three experts unanimously rated the animation's content delivery as Good, while 66.7% considered content understanding to be Excellent, suggesting that while the information was clearly communicated, there may be marginal scope to deepen the nutritional content for specialist audiences. Notably, 100% of experts rated the storytelling effectiveness as Excellent, affirming that the narrative approach is highly effective for information conveyance. This finding is consistent with established research on the Cognitive Theory of Multimedia Learning (Mayer, 2001; Mayer et al., 2005), which demonstrates that narrated animations activating both visual and auditory channels facilitate deeper cognitive processing and superior knowledge transfer compared to static materials alone.

The unanimous Excellent rating for storytelling effectiveness also aligns with Narrative Transportation Theory (Green & Brock, 2000). Transportation theory posits that individuals who become cognitively absorbed in a narrative are more likely to experience story-consistent shifts in their attitudes and beliefs. Murphy et al. (2013) demonstrated that narrative formats were more effective than non-narrative formats in increasing health-related knowledge and attitudes, with transportation, character identification, and emotional engagement each independently contributing to persuasion. The present animation, with its character-driven storyline tracing Hakim's journey from unhealthy habits to dietary awareness, appears to leverage these narrative mechanisms effectively.

The character design item yielded the most distributed ratings, with one-third of experts rating it as Average. This finding aligns with the identified weakness related to cultural identity; the characters, constructed from freely available online assets rather than custom-designed illustrations, lack distinctive Malaysian cultural markers. Research in health communication has consistently demonstrated that culturally tailored interventions produce stronger effects on health behaviours than generic approaches (Kreuter et al., 2003). This limitation is discussed further in Section 5.

Across the Flexibility dimension, all expert responses fell within the Good-to-Excellent range, with 66.7% rating the animation's suitability for promoting positive attitudinal change and facilitating future public health implementation as Excellent. This indicates strong expert confidence in the animation's potential for broader deployment as a health promotion tool, consistent with findings from Tuong et al. (2014), who identified video-based interventions as effective vehicles for health behaviour modification when appropriately designed and targeted.

4.2 Target user evaluation

Target user responses across all 13 evaluation items were highly positive, with the strong majority of responses (203 out of 234 total responses, approximately 86.8%) falling in the Strongly Agree category. Only one instance of Strongly Disagree was recorded across the entire target user evaluation. Table 3 presents key item-level results.

Table 3. Summary of target user evaluation results

Evaluation Item	Agree (%)	Strongly Agree (%)	Mean	SD
Content is straightforward and easy to understand	5.6%	94.4%	3.94	0.24
Narrator's voice is clear and precise	16.7%	83.3%	3.83	0.38
Content is suitable for the general public	5.6%	94.4%	3.94	0.24
Animation helps increase knowledge about healthy eating	11.1%	88.9%	3.89	0.32
Animation appears to strengthen users' intention to adopt healthier dietary behaviour	11.1%	88.9%	3.89	0.32
Animation could serve as an effective awareness measure	27.8%	72.2%	3.72	0.46

The content accessibility findings are particularly notable. The 94.4% Strongly Agree rate for content comprehensibility, combined with a mean score of 3.94 (SD = 0.24), suggests that the animation's linguistic register and visual communication strategies are well-calibrated for diverse audience demographics. This is consistent with the animation's deliberate use of simple vocabulary, subtitle integration, and clear visual metaphors for dietary concepts. These design choices align with Mayer's (2001) Coherence Principle and Signalling Principle, which hold that learning is enhanced when extraneous material is excluded and essential information is highlighted—principles that the clean vector aesthetic of the present animation inherently supports. Notably, Feeley et al. (2023) found that shorter animations of approximately three minutes in duration tend to yield stronger learning effects, consistent with the three-minute runtime of the present animation.

The high accessibility ratings also support findings from Moe-Byrne et al. (2022), who noted that animations may be particularly beneficial for populations with varying levels of education or health literacy. The inclusion of subtitles and clear narration in *You Are What You Eat* further addresses accessibility, accommodating viewers with varying language proficiencies—a critical consideration in Malaysia's multilingual context. These findings also resonate with the work of Aisah et al. (2022), who demonstrated that animated educational videos are culturally acceptable and highly effective at improving health knowledge among Southeast Asian adolescent populations, suggesting strong transferability of the present animation's approach across regional contexts.

The strongly positive response to the animation's potential to strengthen dietary intentions (88.9% Strongly Agree; mean = 3.89, SD = 0.32) is particularly meaningful from a public health perspective. It is important to note, however, that this study relied entirely on a post-test self-report design; accordingly, the findings can only support the claim that users perceived the animation positively and reported stronger intentions toward healthier dietary behaviour—not that the animation directly changed dietary behaviour. Behavioural intention, while a necessary precondition for dietary modification, is not equivalent to actual behaviour change. Future studies should employ pre-post experimental designs and longitudinal follow-up

to assess actual dietary behaviour outcomes. Nonetheless, the Theory of Planned Behaviour (Ajzen, 1991) recognises intention as the most proximal determinant of action, and a meta-analysis by McDermott et al. (2015) confirmed that TPB variables—particularly intention—have medium to large associations with dietary behaviour patterns. The finding that a substantial majority of viewers reported strengthened dietary intentions following a brief animated narrative exposure is therefore a meaningful indicator of communication effectiveness.

This finding is further contextualised by the NHMS 2023 data, which revealed that a significant proportion of Malaysians with undiagnosed NCDs are younger adults, with 84% of young adults aged 18–29 being unaware of their diabetic status (Institute for Public Health, 2023). The animation's digital format and engaging narrative style position it as a potentially effective tool for reaching this younger, digitally-engaged demographic—a population that traditional health communication strategies have historically struggled to engage effectively. The capacity of short animated videos to reach mass audiences across digital platforms has been demonstrated at scale by Vandormael et al. (2021), whose animated health video reached over 6.3 million cumulative views across social media within nine months of release, underscoring the dissemination potential of well-designed animated health content in digital environments.

The effectiveness of the animation's narrative approach can be further understood through Social Cognitive Theory (Bandura, 2004), which posits that individuals learn not only through direct experience but also through observational learning and character modelling. The protagonist Hakim's journey from unhealthy dietary habits to attitudinal reflection provides a vicarious learning experience that may enhance viewers' perceived self-efficacy for dietary change. Murphy et al. (2013) demonstrated that character identification is a key mechanism through which narratives influence health-related behavioural intentions, suggesting that the animation's character-centred approach may be more effective than didactic information delivery.

The comparatively lower Strongly Agree rate for the item 'Animation could serve as an effective awareness measure' (72.2%; mean = 3.72, SD = 0.46) warrants attention. While still strongly positive, this figure suggests that some users may perceive the animation as more effective for personal knowledge enhancement than for broader public health campaigning. This distinction may reflect audience perceptions of scale; individual viewers may feel confident in the animation's personal impact while being less certain of its ability to influence population-level awareness. This finding has practical implications for dissemination strategy, suggesting that the animation should be positioned within a broader, multi-channel health promotion campaign rather than as a standalone intervention (Tuong et al., 2014).

4.3 Theoretical synthesis and implications

The evaluation results, taken collectively, provide convergent evidence supporting the effectiveness of 2D frame-by-frame vector animation as a medium for nutrition health education. The findings can be interpreted through three complementary theoretical frameworks. First, the Cognitive Theory of Multimedia Learning (Mayer, 2001) explains the high content comprehension ratings: the animation's combination of visual and auditory channels, clean vector aesthetics, and narrated exposition facilitates effective dual-channel processing, supporting enhanced understanding. Second, Narrative Transportation Theory (Green & Brock, 2000) accounts for the strong storytelling effectiveness ratings and positive intention outcomes; the character-driven narrative structure engages viewers emotionally, reducing counter-argumentation and fostering story-consistent attitude shifts—a mechanism empirically validated in health communication contexts by Murphy et al. (2013).

Third, the Theory of Planned Behaviour (Ajzen, 1991) contextualises the behavioural intention findings within an established framework of health behaviour prediction. The animation addresses all three TPB determinants: it shifts attitudes through emotional storytelling, establishes subjective norms through character modelling of healthy dietary practices, and enhances perceived behavioural control through practical dietary information delivered via the Doctor character. McDermott et al. (2015) confirmed that

intention is consistently the strongest predictor of dietary behaviour, lending significance to the high behavioural intention scores recorded in this evaluation.

These findings contribute to the growing evidence base supporting animation-based health communication interventions, particularly in diverse national contexts where health literacy challenges, linguistic diversity, and limited engagement with traditional health promotion materials necessitate innovative and accessible communication strategies (Hansen et al., 2024; Moe-Byrne et al., 2022).

5. CONCLUSION

This study demonstrates that two-dimensional frame-by-frame vector animation constitutes an effective, accessible, and engaging medium for nutrition health education targeting the general public. The development of *You Are What You Eat*, guided by the Animation Pipeline methodology and implemented through professional-grade Adobe Creative Cloud tools, yielded an animation product that received consistently positive evaluations from both domain experts and representative target users across content quality, technical execution, effectiveness, and flexibility dimensions.

Expert evaluation confirmed the animation's strength in narrative storytelling—evidenced by unanimous Excellent ratings for storytelling effectiveness—and audio narration quality. Target user evaluation further substantiated these findings, with the overwhelming majority of respondents strongly agreeing across all content, effectiveness, and flexibility items. Specifically, 88.9% of users reported strengthened intentions toward adopting healthier dietary practices following exposure to the animation, a finding theoretically grounded in the Cognitive Theory of Multimedia Learning (Mayer, 2001), Narrative Transportation Theory (Green & Brock, 2000), and the Theory of Planned Behaviour (Ajzen, 1991). Importantly, these findings should be interpreted as indicating positive user perceptions and strengthened dietary intentions, rather than direct evidence of dietary behaviour change, given the post-test-only evaluation design.

Two primary limitations were identified. First, character design was noted by experts as exhibiting some weakness in terms of cultural identity representation. The reliance on freely available online character assets, rather than custom-designed illustrations with distinctly Malaysian visual markers, diminishes the animation's cultural specificity and may reduce its resonance with Malaysian audiences who identify with culturally contextualised media representations (Kreuter et al., 2003). Second, the accuracy of disease-dietary relationship information was identified as requiring enhancement; specifically, the animation's treatment of the health risks associated with excessive sugar consumption—mentioning high blood pressure while omitting diabetes, a more directly relevant consequence—should be corrected in future iterations.

Future work should address these limitations through custom character and environment design with explicit Malaysian cultural representation, rigorous nutritional content review by registered dietitians, and the implementation of character lip-synchronisation technology to enhance realism and viewer immersion. Additionally, the integration of interactive elements—building on the affordances demonstrated by systems such as MyPlate Match—could transform the current linear narrative into a participatory learning experience, further enhancing knowledge acquisition and behavioural intention outcomes. Distribution through Malaysia-specific public health digital channels, including the MyHEALTH portal and relevant social media platforms, would maximise the animation's reach and public health impact. Future evaluative research should also employ larger, more representative samples, pre-post experimental designs, and longitudinal follow-up to assess the animation's impact on actual dietary behaviour change rather than behavioural intention alone (Hansen et al., 2024).

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7. CONFLICT OF INTEREST STATEMENT

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of conflicting interests with the funders.

8. AUTHORS' CONTRIBUTIONS

Nurin Amanina Anuar: Conceptualization, Methodology, Software, Animation Production, Data Collection, Writing Original Draft. **Hamzah Asyrani Sulaiman:** Supervision, Conceptualization, Writing, Review & Editing, Project Administration, Validation. **Che Ku Nuraini Che Ku Mohd:** Writing, Review & Editing, Validation, Formal Analysis. **Mohamad Lutfi Dolhalit:** Writing, Review & Editing, Validation, Formal Analysis. **Nur Saadah Mohd Shapri:** Writing, Review & Editing, Resources, Validation.

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