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Does One Size Fit All? Examining Learning Styles and Gamification in Radiographic Pathology Education

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ABSTRACT

Traditional teaching methods, such as textbooks and lectures, often lack interactivity and engagement, which can hinder comprehension and knowledge retention. Gamification, an innovative educational approach, integrates game elements to enhance motivation and learning effectiveness. However, its impact on radiographic pathology education remains underexplored. This study evaluates medical imaging students' perceptions of gamified learning and its effectiveness across different learning styles, based on the visual, aural, read/write, and kinaesthetic (VARK) model. A prospective cohort study was conducted involving 130 students from a medical imaging programme. Respiratory disease quizzes were set up using Kahoot!. To allow participants to experience learning gamification. Data were collected using a validated VARK questionnaire (version 8.0) to determine learning styles, and perceptions were assessed using a validated questionnaire adapted from the Mobile Application Rating Scale. Data were analysed using Mann-Whitney U and Kruskal-Wallis tests. No significant gender differences were found in perceptions of gamification aspects; both males and females held similar views. However, significant differences were observed by learning style such as aural learners perceived gamification aspects most positively, followed by visual and read/write learners. Kinaesthetic learners rated each aspect lowest, suggesting a need for more hands-on elements. The study indicated a need to personalise learning gamification according to individual learning styles, following the VARK model, while gender factors may be disregarded.

Keywords: *Gamification, Radiographic pathology, Learning style, VARK model, Medical imaging education*

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INTRODUCTION

Medical imaging is a branch of medicine that utilises modalities such as general X-ray, computed tomography, magnetic resonance imaging and ultrasound to visualise human anatomy and physiology for the diagnosis, monitoring or treatment of medical conditions (1). It encompasses a wide range of topics, including radiographic pathology, which, though complex and detailed, is often taught through traditional teaching methods that pose challenges to students' sustained engagement for sufficient comprehension (2).

Gamification is a novel pedagogical approach that is considered effective, as it helps create a meaningful and engaging learning experience for students (3). Dichev and Dicheva (4) defined it as the use of game-based elements to enhance students' experience and motivation within a learning environment. Points, badges, and leaderboards are common gamification elements used as rewards and incentives to motivate students to progress to the next level of challenges (5).

Amid the ample research on gamification as a motivational and educational tool (6), given the increasing reliance on interactive and technology-driven teaching strategies, Oliveira et al. (7) deserve particular attention. They suggested that the current one-size-fits-all approach may yield varied student experiences and learning outcomes due to students' diverse learning preferences (7). Mora et al. (8) considered this understandable, as individuals differ physiologically and are therefore motivated differently; consequently, they recommended personalising gamification to learners' preferences. To achieve this, understanding students' learning preferences is crucial.

Yet research remains limited on the relationship between students varied cognitive preferences and the effectiveness of gamification in education, especially in a medical imaging context. Previous studies, such as Codish and Ravid (9), have examined gender differences in preferences for gamified learning environments and noted that women tend to prioritise simplicity and enjoyment, whereas men often focus on the usefulness of the technology. However, these studies did not investigate perceptions of specific aspects of the gaming experience, such as engagement, functionality, aesthetics, information and the app's subjective quality. Moreover, a significant gap remains in the literature regarding how learning styles affect the acceptance and effectiveness of gamified educational environments (10, 11).

Fleming and Mills' (10) visual, aural, read/write and kinaesthetic (VARK) model provides a framework for categorising learners according to their learning styles, assisting educators in better understanding and responding to students' learning preferences. The model has been empirically validated in various educational fields but has yet to be fully explored in the domain of gamified learning for radiographic education (12). Addressing this gap will significantly inform educators and gamification developers aiming to create inclusive and impactful learning experiences for medical imaging students. Therefore, this study examines how students' different learning styles influence their perceptions and experiences of gamified learning.

METHODS

Study Design

This prospective observational study was conducted at Universiti Teknologi MARA (UiTM) Puncak Alam. It involved 130 radiographic pathology students who were asked to engage in gamified learning activities through a series of respiratory disease quizzes designed using Kahoot!.

Instruments

Questionnaires

The participants' learning styles were identified using the VARK questionnaire version 8.0. They were classified as VARK learners. Their perceptions of their learning experience with Kahoot! as a gamified learning tool were evaluated using a questionnaire adopted from the Mobile Application Rating Scale (13). The questionnaire assessed five aspects including engagement, functionality, aesthetics, information and the app's subjective quality. Responses were recorded on a 5-point Likert scale (1 = poor to 5 = excellent).

A pilot study was conducted to assess the reliability and validity of the questionnaire among 10% of the total study population, who were not included in the final sample. Good internal consistency reliability was confirmed with a Cronbach's alpha value of 0.85 (14). The pilot participants further confirmed the questionnaire's face validity, reporting that the items were clear and comprehensible.

Gamified tool

Kahoot! was selected as the gamified tool primarily because it is freely available and user-friendly, and it supports real-time interaction, making it a practical choice for large classes. Moreover, it had already been used as a supplementary education tool in the Radiographic Pathology course at our institution, which ensured that the students would be comfortable with it, thereby reducing potential barriers to its application.

Sample Selection

Purposive sampling was employed to recruit the target population of 130 undergraduate students formally enrolled in radiographic pathology courses at UiTM. The inclusion criteria were students who had received formal instruction in radiographic pathology and had participated in Kahoot! quiz sessions and had provided informed consent. Students who did not attend the Kahoot! sessions or declined to consent were excluded. Data were collected anonymously to minimise bias, and all the participants were exposed to the same teaching content and gamified activity to ensure consistency.

Data Analysis

Statistical analysis was conducted using IBM Statistical Package for Social Sciences (SPSS), version 29.0. Descriptive statistics were used to provide an overview of participants' demographics, including gender and learning styles. Non-parametric tests were utilised for inferential statistics due to the ordinal nature of the data. Specifically, the Mann–Whitney U test was used to compare perceptions between male and female students, while the Kruskal–Wallis test was used to compare perceptions across learner types. A *p*-value of < 0.05 was considered statistically significant.

RESULTS

Student Demographics

Among the 130 medical imaging students who participated in this study, 21 were male (16.2%) and 109 were female (83.8%). The distribution of the students' learning styles is presented in Table 1.

Table 1: Students' learning styles (n = 130)

Characteristics	n	%
Gender		
Male	21	16.2
Female	109	83.8
Learning styles		
Visual	35	26.9
Aural	22	16.9
Read/write	20	15.4
Kinaesthetic	53	40.8

Differences in Perceptions of Gamified Learning Aspects by Gender

Table 2 presents the comparison of the male and female students' perceptions of gamification in radiographic pathology learning across the five questionnaire aspects. The male students reported mean standard deviation (SD) scores of 12.19 (1.63) for engagement, 17.86 (1.77) for functionality, 12.67 (1.56) for aesthetics, 12.90 (1.61) for information and 14.05 (1.83) for the app's subjective quality. The female students reported corresponding scores of 12.17 (1.94), 17.20 (2.44), 12.57 (1.83), 12.58 (1.85) and 13.88 (2.34). Analysis of gender differences in perceptions of gamified learning revealed no statistically significant variation across any of the five aspects assessed. The Mann–Whitney U test showed that the male and female participants rated the five aspects similarly: (a) engagement (U = 1139.50, p = 0.974); (b) functionality (U = 999.50, p = 0.349); (c) aesthetics (U = 1121.00, p = 0.877); (d) information (U = 1008.00, p = 0.377); and (e) the app's subjective quality (U = 1113.50, p = 0.838).

Table 2: Gender differences in perceived value of gamified learning aspects

Aspects	Gender (n)	Mean (SD)	Mean rank	U value	*p*-value*
Engagement	Male (21)	12.19 (1.63)	65.74	1139.50	0.974
	Female (109)	12.17 (1.94)	65.45		
	Male (21)	17.86 (1.77)	72.45	999.50	0.349
	Female (109)	17.20 (2.44)	64.16		
	Male (21)	12.67 (1.56)	66.64	1121.00	0.877
	Female (109)	12.57 (1.83)	65.28		
	Male (21)	12.9 (1.61)	71.98	1008.00	0.377
	Female (109)	12.58 (1.85)	64.25		
	Male (21)	14.05 (1.83)	67.02	1113.50	0.838
	Female (109)	13.88 (2.34)	65.21		

Note: *no statistically significant differences were observed ($p > 0.05$).

Differences in Perceptions of Gamified Learning Aspects by Learning Style

Significant differences emerged in the perceptions of gamification across learning styles (Table 3). The Kruskal–Wallis test results showed that the engagement ratings varied significantly ($p < 0.001$), with aural learners reporting the highest levels of engagement, followed by visual and read/write learners, while kinaesthetic learners exhibited the lowest scores. Functionality also differed significantly among the groups ($p = 0.034$), with the aural learners perceiving the tool as highly functional, whereas the kinaesthetic learners rated it lower, indicating usability challenges. Aesthetic preferences showed a similar trend, although the differences were not statistically significant ($p = 0.06$) such as aural learners provided the most positive ratings, and kinaesthetic learners the lowest. Perceptions of information quality also varied significantly ($p = 0.002$), with the aural learners rating it highest, and the kinaesthetic learners, lowest. The app's subjective quality was significantly influenced by the students' learning styles ($p < 0.001$), with the aural learners demonstrating the highest satisfaction and the kinaesthetic learners reporting the least favourable perceptions.

Post-hoc pairwise comparisons using the Mann–Whitney U test with Bonferroni adjustment showed that the aural learners consistently rated the gamified environment more positively than the kinaesthetic learners across engagement (U = 453.00, $p < 0.001$), functionality (U = 720.00, $p = 0.028$), information (U = 681.00, $p = 0.003$) and the app's subjective quality (U = 702.50, $p < 0.001$). The visual learners also reported higher engagement than the kinaesthetic learners (U = 242.00, $p = 0.002$). The aural learners rated the app's subjective quality significantly more highly than the read/write learners (U = 312.50, $p = 0.004$).

Table 3: Learning style differences in perceived value of gamified learning aspects

Aspects	Learning style (mean rank)				*p*-value
	Visual (n = 25)	Visual (n = 22)	Read/Write (n = 20)	Kinaesthetic (n = 53)	
Engagement	77.91a	85.07a	70.15	47.42b	< 0.001
Functionality	69.39	80.30a	70.83	54.78b	0.034
Aesthetic	68.70	80.05	69.65	55.78	0.06
Information	68.46	88.20a	69.05	52.78b	0.002
App subjective quality	68.29	99.14a	56.25b	53.19b	< 0.001

Notes: Superscript letters (a, b) denote groups that significantly differ in post-hoc pairwise comparisons (Mann–Whitney U with Bonferroni adjustment); n = sample size per learning style group; Kruskal–Wallis test was used to determine overall significance.

DISCUSSION

The findings highlight the influence of learning styles on students' perceptions of gamified learning in radiographic pathology education. While gender did not significantly affect perceptions, learning styles played a crucial role in shaping students' views of engagement, functionality, aesthetics, information quality and overall satisfaction with the gamification approach.

Differences in Perceptions of Gamified Learning Aspects by Gender

The absence of gender-based differences in this study aligns with findings from previous studies showing that male and female students are equally engaged with gamified learning environments when instructional design is well-structured and inclusive (15). Similarly, Fuchs (16) reported no significant differences between male and female students in perceived engagement when Kahoot! was used. Some studies have suggested gender differences in preferred game mechanics, such as competition and rewards (8). However, the results of the present study indicate that these differences are negligible in learning radiographic pathology.

These findings suggest that gamified educational tools can be designed without gender-specific modifications, making them universally applicable in medical imaging education. Indeed, gamification elements such as points, badges and leaderboards are considered universally appealing. Nylén-Eriksen et al. (17) found that, across gender groups, serious games and gamification significantly improved students' academic performance, clinical decision-making and learning satisfaction.

Differences in Perceptions of Gamified Learning Aspects by Learning Style

Conversely, important variations in perceptions of gamification were noted according to learning style, verifying the notion that a universal strategy for gamified learning might not work (5). Yan et al. (18) found that students' learning styles are potential mediators of the perceived usefulness of gamified learning tools, suggesting that teachers should consider the sensory stimuli produced by game elements in their teaching approaches.

In the present study, the aural learners, who reported the highest levels of engagement, regarded the gamified tool as the most useful and educational. This finding is consistent with prior research showing that gamified resources incorporating spoken explanations, interactive dialogues and auditory feedback improve learning among students who prefer spoken and listening interactions (19). The visual learners also demonstrated high levels of engagement, aligning with earlier findings that visual components such as animations, images and colour-coded feedback enhance comprehension in gamified learning (20).

By contrast, the kinaesthetic learners rated gamified learning lowest in several categories, likely reflecting their preference for experiential, movement-based learning (21). While Kahoot! offers incidental movements such as tapping and selecting responses, the literature provides only limited evidence that it fully supports kinaesthetic learning preferences. Pascu (22) suggested that some physical interaction in answer selection may partially engage kinaesthetic learners, but no empirical study has confirmed that Kahoot! meets the full spectrum of kinaesthetic learning demands. Previous research has proposed that gesture-based interactions, simulations or virtual reality components could enhance kinaesthetic learners' gamified learning experience (23).

The significant differences observed in perceptions of functionality and information delivery further emphasise the importance of tailoring gamified learning experiences to diverse learning styles. Aural learners rated information quality highest, appreciating clear menu labels and intuitive navigation, whereas kinaesthetic learners reported lower satisfaction, suggesting challenges in usability and interaction design that may affect their learning experience. These findings align with previous research indicating that the effectiveness of gamification depends on how well it aligns with learners' cognitive preferences and processing styles (7).

The predominance of kinaesthetic learning preferences in this cohort may have been influenced not only by inherent student differences but also by the structure and demands of the medical imaging curriculum. Because the curriculum places strong emphasis on supervised, hands-on tasks such as image acquisition and patient positioning, students receive frequent reinforcement of direct physical interaction as part of their routine learning (24). Moreover, practical training and clinical placements have been shown to deepen technical knowledge and skills in radiography contexts (25).

These insights highlight the need for more dynamic and customisable gamified learning platforms that can accommodate individual learner profiles. Future development should explore adaptive learning algorithms that personalise the experience in real time by responding to user interaction patterns and feedback. Interdisciplinary collaboration between educators, instructional designers and software developers could help bridge the gap between pedagogy and technology. In this way, gamified learning tools could evolve beyond static quiz formats to include role-playing simulations, decision-making scenarios and interactive storytelling elements that appeal to a wider range of learners.

This study has a few limitations. First, it employed a single Kahoot! quiz to evaluate students' perceptions of gamified learning. While this approach provided valuable insights, the duration and frequency of the students' exposure to it may have influenced their experiences and reported perceptions. Repeated use of gamification across multiple sessions or over an extended period may yield different levels of engagement and learning outcomes. Therefore, future studies should examine how sustained or repeated gamified activities shape student perceptions compared with one-time exposure. Second, the sample was predominantly female (83.8%). Although this reflects the gender distribution in the medical imaging department at our institution, it may limit the generalisability of the findings. Third, the data were collected from a single academic institution, which may restrict the external validity of the findings. Expanding the study to include multiple institutions would enhance its applicability. Finally, pre- and post-intervention academic performance data were not collected, limiting the ability to objectively measure learning gains associated with gamified learning tools.

CONCLUSION

This study revealed that male and female students perceive gamified learning in radiographic pathology similarly, whereas VARK learners with different styles perceive it differently. Aural and visual learners responded most positively to Kahoot!, while kinaesthetic learners reported lower satisfaction with it, likely due to its limited hands-on interactivity. These findings underscore the inadequacy of a one-size-fits-all approach and highlight the importance of designing adaptive gamified tools that align with diverse learning preferences in medical imaging education. Further research is recommended to explore the effects of sustained exposure to gamification and the use of multimodal tools such as augmented or virtual reality, alongside objective measures of learning outcomes, to evaluate the long-term effectiveness of gamified learning.

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ETHICAL APPROVAL

Ethical approval was obtained from the Faculty Ethics Review Committee of the Faculty of Health Sciences, UiTM Puncak Alam (approval no. FER/FSK/MR/2024/00037). Written informed consent was obtained from all the participants after they were assured of confidentiality and informed of their right to withdraw from the study at any stage without consequence.

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