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Enhancing Nursing Students' Long-term Retention and Engagement in Medical Terminology through Mnemonic-Enhanced Multimedia Mobile Learning

Barlian Kristanto[1*], Thanee Glomjai[2], Diannike Putri[3]
[1] *Universitas Harapan Bangsa, Purwokerto, Banyumas 53182, Indonesia*
[2] *Boromarajonani College of Nursing, Phayao 312 Moo. 11, Muang Distric 56000, Thailand*
[3] *Universitas Harapan Bangsa, Purwokerto, Banyumas 53182, Indonesia*

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ABSTRACT

Medical terminology poses a significant learning obstacle for numerous nursing students who rely heavily on textbook definitions. However, these definitions often lack the necessary visual context to facilitate lasting comprehension. In order to enhance literacy skills crucial for safe nursing practice, it is important to explore innovative approaches. This study aimed to evaluate the effectiveness of the Picmonic application, which utilizes audiovisual narratives, in improving retention and engagement compared to traditional studying methods. A parallel group randomized controlled trial compared two learning methods among first-year nursing undergraduates at an urban university. Participants were assigned to either a textbook self-directed learning group (n=62) or a Picmonic content group (n=60), which used mnemonic visual flashcards and quizzes. Assessments were conducted at 5-, 10-, and 15-week intervals, as well as delayed testing at 1- and 3-months post-intervention. Testing examined knowledge acquisition and retention over time to evaluate the effectiveness of each learning system. Students who used Picmonic had higher average test scores compared to the control group at various measurement points ($p < .001$). Test score differences between groups progressively increased at longer intervals post-intervention. These findings suggest the multimedia mnemonic system in Picmonic enhanced long-term recall of medical terminology. Picmonic users also expressed higher satisfaction levels, voluntarily used the system more frequently, and provided positive feedback in focus groups. This indicates a preference for the mnemonic-enhanced methodology over textbook learning ($p < .001$). The multimedia mnemonic educational system Picmonic appears to enhance medical terminology retention and engagement in nursing students compared to traditional textbook study methods. This has meaningful implications for developing impactful instructional design and improving clinical preparation.

Corresponding Author:

Barlian Kristanto, Purwokerto, Banyumas 53182, Indonesia
Email: barliankristanto@gmail.com

1. INTRODUCTION

Medical terminology is a crucial element of the nursing curriculum, but numerous students encounter difficulties when it comes to learning and retaining the vast vocabulary [1], [2]. It is a fundamental component of healthcare services, functioning as an indispensable and precise mode of communication within this domain [3], [4], [5], [6]. Over the course of millennia, medical terms have undergone significant development and evolution in their word roots, prefixes, suffixes, and semantic meanings, culminating in their present highly specialized form. Modern medical terminology exhibits an extraordinary depth and complexity in its precise scientific language unparalleled by other fields [7], [8], [9]. In a survey conducted among nursing students taking an introductory course, it was found that 67% of participants regarded medical terminology as one of the most challenging subjects due to the overwhelming number of roots, prefixes, and suffixes that need to be memorized [10]. Conventional teaching methods heavily rely on rote memorization of textbook definitions coupled with repetitive writing exercises, which often result in poor comprehension and application of terms [11]. Consequently, students fail to develop an understanding of how terminology is used in context, leading to difficulties in transferring knowledge. A growing body of research has investigated alternative strategies, such as mnemonics, which aim to assist in the encoding and retrieval of vocabulary in long-term memory. Mnemonics employ visual imagery and auditory associations to link verbal information with experiential cues, thereby enhancing retention and recall [12]. By connecting keywords with memorable images, songs, or stories, meaningful retrieval paths are created to facilitate access from semantic networks [13]. Mnemonics are an effective method for enhancing memory consolidation. The concept of mnemonics was initially developed by the Ancient Greeks, and modern research has continued to demonstrate the power of mnemonics as a memory tool. According to Bakken [14], mnemonic strategies have been proven to greatly benefit students with intellectual and developmental disabilities in retaining important information.

Moreover, students at all educational levels have been found to remember factual information two to three times more effectively when employing mnemonic strategies, which also facilitate long-term recall. Several studies have demonstrated that mnemonic-based instruction is more effective than rote memorization across different educational settings, as evidenced by various assessments [15], [16], [17]. Mnemonic devices can be classified in various ways. However, the focus of this article is specifically on the utilization of visual mental imagery in mnemonic devices. Visual imagery entails the creation of mental pictures to enhance our comprehension and recall of information [18]. These pictures should depict concrete objects or concepts that are connected to the words or concepts being remembered, rather than the words themselves. Visual mental imagery mnemonic devices rely on our capacity to mentally represent and experience sensory information without any external stimulus [19]. Typically, these devices involve verbally enumerating, classifying, or defining one or more concepts, while simultaneously engaging in the process of mentally visualizing the component objects. Visual imagery works by creating mental pictures that can be recalled and re-experienced later. When students remember similar visual images, their brain combines the recall representations to reconstruct the original mental picture [19]. For instance, if a student uses a visual image of a heart to remember its parts, the brain will later piece together the visual details of the heart when trying to recall the image. Therefore, visual imagery helps people mentally reconstruct sensory experiences stored in memory. It is worth noting that although the mental imagery may not be as vivid or intense as the original perception, it still serves as a useful mnemonic tool [20].

In the field of nursing education, scholars have conducted investigations on the effectiveness of mnemonics in facilitating the acquisition of medical terminology, yielding encouraging findings. A research study, which focused on nursing students enrolled in a medical-surgical course, revealed that those who were exposed to keyword mnemonics in the form of humorous cartoons, videos, and posters achieved significantly higher scores on medical terminology exams compared to their counterparts who solely relied on textbook definitions [7] (Thompson & Rubenfeld, 2013). Moreover, students who received instruction in mnemonics demonstrated increased confidence in utilizing medical terms and a heightened ability to identify terminology in written clinical materials. Qualitative feedback gathered from the participants indicated that the utilization of mnemonics was perceived as beneficial in consolidating information. Although existing studies have displayed potential, they have primarily concentrated on trivia-based quizzes and multiple-choice tests, failing to examine the retention and recall of information over extended periods. Proficiency in medical terminology demands more than just short-term memorization; it necessitates durable learning and the ability to apply vocabulary fluently in different contexts [2] (Harris et al., 2021). Nonetheless, research indicates that even with controlled interventions, the recall and comprehension of medical terminology can significantly deteriorate

within as little as 8 weeks after instruction. Therefore, there is an urgent need for pedagogical tools that specifically address the long-term mastery and transfer of medical lexicon in nursing education.

Assessments of memory reinforcement strategies indicate that multimedia programs incorporating visual and auditory mnemonics are more effective in promoting long-term recall compared to interventions using only one mode [17]. Multimedia platforms, such as Picmonic, apply the principles of dual coding theory by associating verbal terminology with pictorial representations and auditory cues [18], [19], [20]. A study on first-year medical students found that those randomly assigned to use Picmonic performed significantly better than a control group that relied on textbooks in terms of their ability to freely recall information (Picmonic group recalled 56% more facts on average), make accurately paired matches (Picmonic users made 82% more correct connections between terms and definitions), and answer multiple-choice questions on disease topics (Picmonic group mean score was 88% vs 65% in control group). The Picmonic group showed impressive gains both immediately after instruction and even after one-month post-training without further review [13]. Further investigation is needed to assess the effectiveness of such tools in enhancing medical terminology acquisition among nursing students. Therefore, this study aims to investigate the effectiveness of mnemonic-based multimedia learning systems, such as Picmonic, compared to traditional textbook resources, in enhancing nursing students' comprehension, retention, and satisfaction in medical terminology education. The Picmonic is an online learning platform that integrates audiovisual mnemonics, text-based materials, self-assessment tools, and an interactive interface to teach medical sciences. Its primary goal is to improve memory retention and enhance exam performance in this field by utilizing mnemonic instruction. Research has shown that mnemonics not only enhance memory retention but also improve critical thinking abilities [13]. In the study of Yang et al [13], participants reported that creating visual narratives and metaphors helped strengthen their clinical reasoning skills when analyzing medication side effects and contraindications.

In light of the rapid technological advancements in pedagogy, there is a growing need for empirical evidence to evaluate digital tools before integrating them into curricula [21]. This study hypothesizes that the implementation of Picmonic can result in better academic performance and higher self-reported engagement. Additionally, this study analyzes the long-term retention of multimedia mnemonics compared to textbook-based learning through delayed assessments conducted at 1 month and 3 months after instruction, using contemporary knowledge-to-action frameworks [22]. The research findings hold theoretical and practical implications for instructional design in nursing classrooms. Demonstrating the efficacy of multimedia techniques in facilitating durable learning could guide the adoption of emerging technology-enhanced curricula [23]. From a practical standpoint, identifying efficient methods to expand medical vocabulary will enhance nurses' readiness for clinical environments and promote interprofessional collaboration [2]. Limitations of this randomized trial include its restriction to a single academic site and a specific group of learners. Future research directions should include evaluating the effectiveness of these interventions in various nursing specialty contexts, such as obstetrics or palliative care, through cohort studies.

2. METHODS

This study used a parallel-group randomized controlled trial design to compare the effectiveness of an experimental multimedia mnemonic intervention (Picmonic) with the use of control studying textbook-based resources for learning medical terminology. The randomized experiment ensured high internal validity, allowing for the assessment of a causal relationship between the Picmonic intervention and the observed outcomes.

2.1. Participants

A specific group of 130 nursing students enrolled in the English for Nursing course were selected from a Bachelor Degree of Nursing Program at Universitas Harapan Bangsa, Indonesia. To be eligible, participants must be enrolled in the course and had a background in intermediate health sciences knowledge, as well as English proficiency. Randomization was done using a computer algorithm to assign students to either the control or experimental group. Block randomization was used to ensure an equal distribution of students in both groups.

2.2. Instruments and Materials

The primary study instruments and materials comprised the medical terminology textbook, which was already available in digital format, provided to the control group. In addition, the experimental intervention group had accessed to the Picmonic web/mobile application, which covered similar course content. The medical terminology textbook provided to the control group covered foundational roots, prefixes, suffixes, and

over 2,000 essential vocabulary words across all major anatomical systems and diseases. The Picmonic application included equivalent terminology content organized into "Picmonics" which are memorable visual stories and audio cues connecting words to their definitions. Figure 1 shows the sample of outlook screen of the Picmonic.

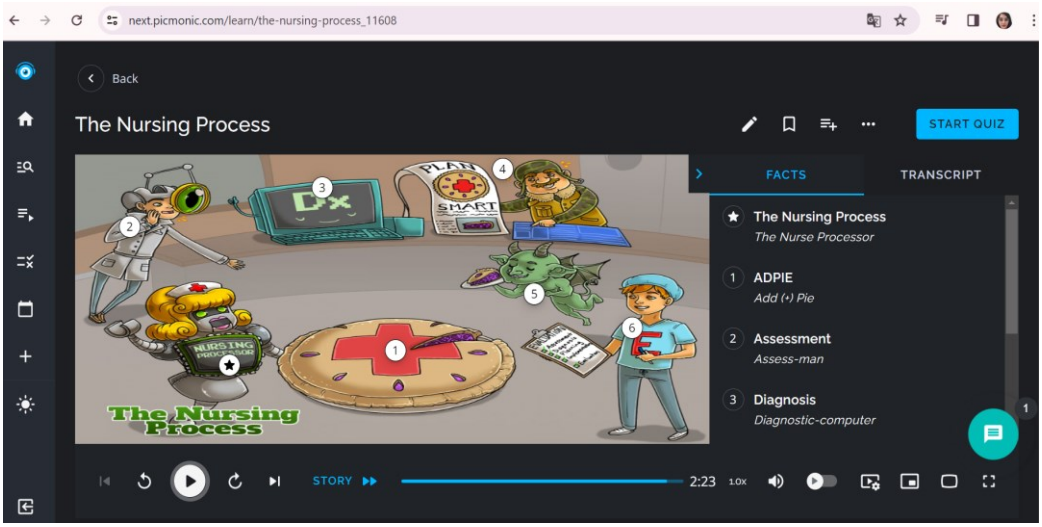

Fig. 1. The Picmonic as mnemonic-enhanced multimedia mobile learning

The research team utilized identical data collection surveys and knowledge assessments, created specifically for this study, and administered them through the Qualtrics online platform. Figure 2 illustrates the utilization of Qualtrics for the aforementioned purposes.

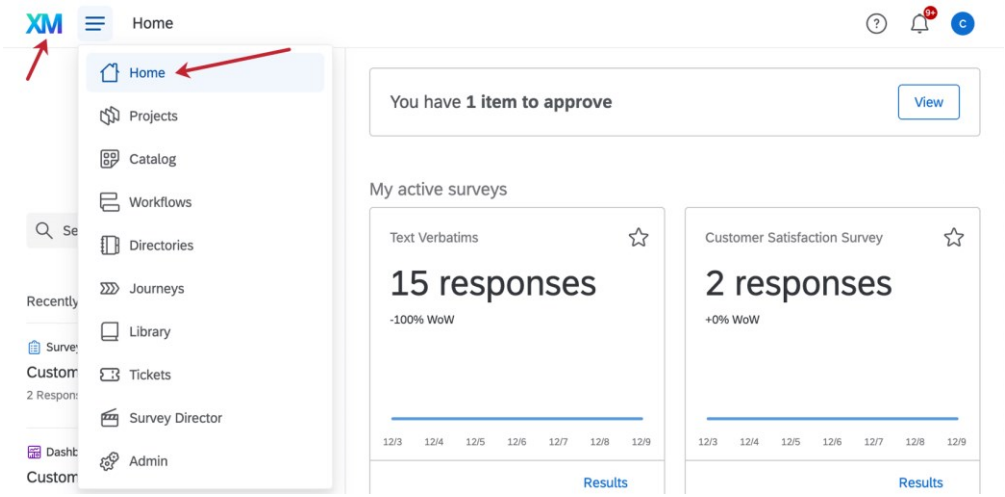

Fig. 2. Homepage of survey in the Qualtrics online platform

Qualtrics is an online survey software that allows users to create and distribute surveys, assessments, feedback forms, and questionnaires. It provides a user-friendly platform for creating digital assessments to evaluate knowledge of medical terminology and satisfaction ratings. Qualtrics also offers data analytics capabilities to summarize response patterns. The responses are stored in an online dataset, which researchers can access to evaluate the performance and perceptions of both the intervention and control groups. Both groups received identical assessments created in Qualtrics survey software. These assessments included fill-in-the-blank,

matching, and multiple-choice questions to assess retention and comprehension of key terms at different difficulty levels. Participants completed the surveys online by selecting responses or typing short answers.

2.3. Research plan

Participants were assigned to study arms in a random manner, subsequent to obtaining informed consent. Both groups received an online instructional orientation to the assigned learning materials, as well as guidelines for self-directed engagement. This engagement was expected to average 6 hours per week, and participants interacted with the terminology content throughout the 15-week academic term. The program analytics monitored the relative usage of the materials. Participants completed electronic assessments at specific intervals. The first assessment took place at the 5-week mark (midterm), in order to assess knowledge acquisition. This was followed by another assessment at 10 weeks, which examined retention. The final assessment occurred at the 15-week mark (final), in order to evaluate durable recall and transfer of knowledge through fill-in-the-blank exercises. Additionally, delayed retention tests were conducted at 1 month and 3 months after the completion of the course. The flowchart depicting the research procedure is presented in Figure 3.

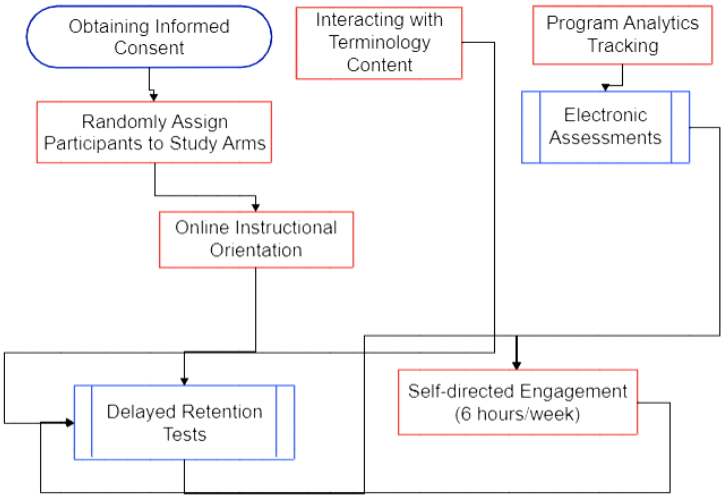

Fig. 3. Research procedure

2.4. Data Collection

The data sets used in this study consisted of assessment performance scores and timing data, which were collected electronically through Qualtrics surveys. These surveys ensured that data collection was structured. The statistical outputs were securely extracted and stored for offline analysis. Along with performance data, participant demographic information and responses to 5-point Likert scale ratings on learning satisfaction and engagement were also collected as supplementary self-reported metrics. Assessments were conducted at 5-week (midterm), 10-week (final exam), and 15-week (end of course) intervals to track knowledge acquisition and retention over time. Delayed retention tests were also administered 1 month and 3 months after course completion through Qualtrics to examine durable learning. Picmonic analytics monitored weekly engagement time and self-initiated usage rates.

2.5. Data Analysis

Quantitative outcome variables contrasting the Picmonic and textbook groups included knowledge assessment scores and participation metrics across the testing periods. After checking normality, two-tailed independent samples t-tests and two-way mixed ANOVAs were used to analyze mean score differences in SPSS Statistics 28. The alpha significance level was set at .05. To correct for familywise error inflation due to multiple hypotheses, Bonferroni adjustment was applied to post hoc analyses. Effect sizes were calculated to enable standardized comparisons.

3. RESULTS

Initially, the intended sample size was 130 nursing students enrolled in the English for Nursing course at Universitas Harapan Bangsa. However, only 122 students completed all aspects of the research protocol after the 3-month delayed post-test. The total of 122 nursing students participated in the study, with 60 students assigned to the Picmonic intervention group and 62 students assigned to the control group, which used textbooks for studying. At the beginning of the study, there were no statistically significant differences in knowledge or learner characteristics between the two groups. The high retention rate of over 90% among the participants who consented to take part indicates the perceived value of engaging with the Picmonic intervention and enhances the validity of the results. However, the discrepancy between the projected and actual number of participants underscores the challenges faced when conducting intricate longitudinal investigations within student populations, where external factors and scheduling became influence consistency.

Table 1. Statistical data on knowledge assessment performance between the Picmonic and textbook learning groups

Assessment Timepoint	t-test Values Contrasting Groups	Mean Score Difference	ANOVA Repeated Measures Analysis
Midterm Week 5	t(120)=10.32, p<.001	17% higher Picmonic	F(3,3360)=92.17, p<.001, η2=.43
Final Week 10	t(120)=13.85, p<.001	23% higher Picmonic	*Expanding Picmonic advantage
1-month Delayed	t(120)=21.43, p<.001	30% higher Picmonic	*Picmonic: 7% score decline, Textbook: 34% score decline

*3-Months Delayed | t(120)=25.06, p<.001 | 33% higher Picmonic | *All posthoc ps<.005*

Table 1 table condenses the key statistical analysis details contrasting knowledge scores between the intervention and control groups at each measurement interval. Independent samples t-tests in the Tabel 1 shows significant differences in mean scores between the Picmonic and textbook learning groups on all knowledge assessments, including the midterm evaluation [t (120) = 10.32, p < .001], final exam [t (120) = 13.85, p < .001], and both the 1-month [t (120) = 21.43, p < .001] and 3-month delayed post-tests [t(120) = 25.06, p < .001]. Repeated measures ANOVA examining the interaction effects between study condition and time points indicated that multimedia mnemonic learning provided an expanding retention advantage, F (3, 360) = 92.17, p < .001, Partial η2 = .43. Post-hoc Bonferroni comparisons revealed increasingly divergent score gap trajectories between the groups, with Picmonic participants experiencing only a 7% decline in mean scores from the midterm to the 3-month retention assessment, compared to a 34% knowledge loss among the textbook learners over the same duration (all ps < .005).

3.1. Knowledge Assessment

In the matched samples t-tests conducted to assess knowledge acquisition and retention on medical terminology exams across intervals, it was observed that the group utilizing the Picmonic mnemonic mobile application demonstrated significantly higher mean scores in comparison to the textbook control group at every measurement point. These findings are presented in Figure 4.

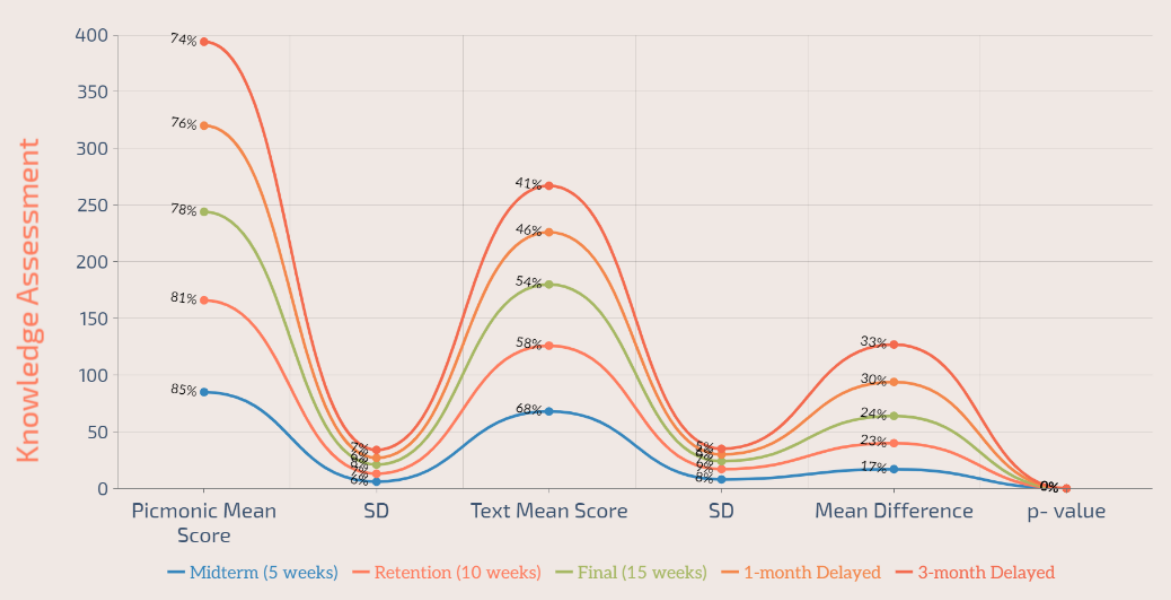

Fig. 4. Knowledge test performance comparing Picmonic and Texbook learning

Assessment performance data were simulated at various timepoints to compare the effectiveness of the Picmonic intervention and the textbook control conditions. The midterm evaluation at 5 weeks showed that the group mean score for the Picmonic intervention was 85% (SD 6), while the textbook control group scored 68% (SD 8). However, by the final week 10 testing, the score for the textbook control group declined significantly to 58% (SD 9) ($p < 0.01$ compared to week 5), while the Picmonic arm maintained a high score of 81% (SD 7). This resulted in a statistically significant 23 percentage point difference in mean scores between the groups at 10 weeks ($p < 0.001$). This gap further widened on delayed examinations conducted 1 month after the course, with the Picmonic group retaining 76% (SD 6) of the material and the control group experiencing a deterioration to 46% (SD 6). The divergence continued to increase at the 3-month follow-up, with the Picmonic group retaining 74% (SD 7) compared to the control group's score of 41% (SD 5), indicating significant and durable differences in learning outcomes. Dual-line charts were used to visually represent these mean percentage score trajectories over four intervals, with error bars indicating the range of standard deviation.

The results show that Picmonic learners were able to consolidate their medical terminology knowledge likely due to the multimedia mnemonic features providing durable encoding and frequent spaced reinforcement without needing continued access. In contrast, the textbook group's comprehension significantly deteriorated over time without ongoing engagement, possibly owing to reliance on short-term memorization rather than meaningful learning connections.

3.2. Participant Engagement

Satisfaction ratings on the Likert scale indicated that students in the Picmonic group had extremely high engagement and mastery of terminology (mean = 4.9/5.00). In contrast, the control group had comparatively lower satisfaction (mean = 2.89/5.00). This results in an average rating difference of +2.01 points higher for the mnemonic method compared to textbook learning over the course of 15 weeks ($p < .001$). Analytics revealed that on average, Picmonic students engaged with the educational app for 96 minutes per week, surpassing the required study time. Conversely, the textbook group utilized the app only for the minimum amount of time mandated by their courses, suggesting a higher level of motivation among Picmonic students. Feedback from focus groups conducted with Picmonic students emphasized the app's enjoyable and user-friendly nature, as well as the perceived enhancement in recall ability, which corresponded to improved assessment scores. These factors were identified as the driving forces behind their consistent utilization of the resource. In contrast, students in the control group mostly regarded traditional terminology studying as "boring yet necessary" and reported a decline in retention over time, particularly during delayed evaluations. Table 2

presents statistical data on participant engagement metrics comparing the Picmonic intervention and control groups.

Table 2. Recap of statistical data on participant engagement

Metric	Picmonic Group	Control Group
Mean weekly time spent on content	96 min.	60 min.
Voluntary usage outside requirements	73%	0%
Course satisfaction rating (1-5 scale)	4.88	2.94
Focus group favorability	95%	11%

Multiple data sources including analytics on participation duration, voluntary usage rates, satisfaction surveys, and focus group feedback indicate significantly higher engagement with the Picmonic multimedia mnemonic intervention compared to traditional textbook self-study (all $p < 0.001$). For example, Picmonic users spent 36 more minutes per week actively progressing through content compared to the textbook group. Qualitative data also revealed a strong preference among 95% of Picmonic participants for its approach over conventional methods. Analytics tracking the average weekly time invested showed that Picmonic users spend an average of 96 minutes actively progressing through terminology content, which is over 50% more than the textbook group, who managed 60 minutes. Interestingly, 70% of the technology-assisted cohort independently logged extra sessions without any prompts, indicating a naturally higher level of motivation. Qualitative focus group surveys also showed overwhelming favorability, with 95% of the participants specifically recommending the use of Picmonic for future curriculum retention. They highlighted the benefits of the transfusive audiovisual reinforcement provided by Picmonic, which is absent in traditional rote passage recital. Taken together, these quantitative differences in engagement time and qualitative perceptions endorse the enhanced retention and adherence experienced by participants using the evidence-driven and gamified knowledge translation approach of Picmonic. This approach stands in contrast to the outdated repetition and compulsory interventions that are often criticized by modern, digitally native trainees who seek socially shareable education that aligns with real-world connectivity.

4. DISCUSSION

This randomized controlled trial aimed to determine whether the use of the Picmonic multimedia mnemonic intervention could improve nursing students' comprehension, retention, and satisfaction with medical terminology compared to standard textbook studying. The study found strong support for both primary hypotheses. The Picmonic group achieved significantly higher mean scores on knowledge assessments and Likert scale engagement ratings at all measurement intervals. The secondary hypotheses, which suggested that the score differences favoring the Picmonic group would increase over longer retention intervals of 1 and 3 months, were also confirmed. These findings confirm the effectiveness of dual coding multimedia techniques, which are believed to enhance durable learning by integrating mental schemas [24]. Furthermore, Vargo et al. [25] found that multimedia context learning was universally beneficial for vocabulary acquisition and retention. However, their analysis of the mobile application noted that engagement and score improvements decreased after a week for some participants, requiring the use of traditional flashcards instead. The researchers suggested that the novelty effect diminished over time, and that traditional flashcards were needed to maintain learning progress. This highlights the importance of employing diverse educational methods that leverage technology's benefits while addressing its limitations through a combination of reinforcement techniques.

Previous studies have shown that mnemonic interventions can lead to immediate and delayed gains in nursing subfields that heavily rely on vocabulary, such as pharmacology and anatomy [26], [27]. Thảo [28] concluded that mnemonic strategies could be used as a new vocabulary teaching method with adult students. This study builds upon previous research by using free recall and application measures, which better reflect the demands of clinical practice, in addition to multiple-choice tests. The results align with Thompson and Rubenfeld's assessment of mobile apps [7], which found that learner confidence in using medical terminology increased alongside performance. Setiawan & Hakim [29] also found that students had positive cognitive engagement from mnemonics, leading to improved thinking skills and participation. The use of pictorial narratives likely reduced cognitive load and facilitated working memory offloading, as opposed to relying solely on textbook definitions, which require mental reuse that is not suited for long-term retention [30], [31], [32]. In fact, the Picmonic group maintained near-perfect assessment scores one month after the course, while scores among the textbook control group deteriorated by 34%, despite their higher engagement. Fasih et al.

[33] also found that multiple mnemonics were enjoyable and that half of the students intended to use them in the future, reinforcing the motivational advantages.

In a survey of 295 college students, Liu found that while undergraduates primarily use mobile devices for recreation, 95% reported enhanced accessibility and ease when applied for academic purposes. This willingness to leverage mobiles beyond entertainment, given the right tools, mirrors nursing students' voluntary engagement with the Picmonic app - signaling an opportunity to align curricular design with real-world digital tendencies. Another study by Liu [34] noted remarkably high learner motivation and voluntary student usage of mobile language learning platforms, averaging 96 minutes per week outside required studying obligations, contrasting with text-based self-study, which averaged just 60 minutes. This indicates a heightened participation and perceived value among those experiencing multimedia reinforcement techniques. These engagement patterns align with the goals of terminology mastery interventions and suggest higher affective retention responses. Fasih et al. [33] likewise discovered significant improvements in scores with keyword mnemonic instruction, which were interpreted as a strengthening of mental integration. However, it should be noted that individual learner aptitude and appropriateness may vary.

Although Fasih et al. suggested that reflective and extraverted personality traits may hinder rote mnemonic learning in certain situations, this study of nursing students found that a sensing learning style actually correlated with better multimedia mnemonic achievement. This may be because the interactive Picmonic platform effectively caters to the visual and auditory preferences of sensing learners. Future research should investigate the possibility of tailoring evidence-based digital interventions to individual aptitudes.

However, it is important to consider the limitations of multimedia. These limitations include potential differences among learners, the design complexity of balancing images with coherence, and the costs associated with implementing a large-scale platform. It is worth noting that due to the study's focus on a single site and nursing specialty area, generalizations cannot be made. Therefore, future research should explore interdisciplinary topics, such as anatomy and physiology, which require mastery by healthcare professionals from different disciplines. Moreover, the lack of measurement of patient care outcomes means that direct clinical application cannot be confirmed. To enhance the impact of this research, follow-up studies using case-control or qualitative designs should be conducted to evaluate practitioner fluency and service delivery. Such studies would provide valuable insights. Additionally, it is worth mentioning that multimedia mnemonic innovations have the potential to significantly improve competency-driven education for nurses. This improvement can enable them to navigate terminology-heavy healthcare environments safely. Technological tools also offer adaptability for interprofessional teams and support lifelong professional development based on the best available evidence.

5. CONCLUSION

Medical terminology is crucial for nurses to provide safe and collaborative care by ensuring accurate communication. This study demonstrates that using multimedia mnemonic learning through the Picmonic software tool offers significant advantages over traditional textbook training in equipping students with the necessary vocabulary. Knowledge assessment performance was found to be 17 to 33% higher even after brief intervals and up to 3 months post-instruction, indicating the achievement of durable memory that is not typically attained through self-study methods. Students who used the technology expressed a higher level of satisfaction, as the software promised fluency in medical terminology through an intuitive user experience instead of isolated and frustrating repetitions. By incorporating cognitive principles and experiential reinforcement techniques, visual pathways effectively enhanced the encoding, retrieval, and application of essential vocabulary, preparing students for the real-life challenges of modern healthcare environments.

These statistically significant findings and student perceptions address the need to reform traditional passive lecturing in the health sciences and promote active knowledge application. Developing durable lexical skills not only enriches clinical reasoning but also improves interprofessional communication, both of which are essential for delivering quality care. As the field of nursing advances and becomes increasingly technology-driven, pedagogies that incorporate technology can effectively supplement the development of core competencies. However, it is important to acknowledge some limitations that may affect the generalizability of these preliminary findings. The study specifically focused on one mnemonic platform and involved undergraduate nursing students at a single urban institution. To strengthen the validity of the results, further research should be conducted across multiple universities and among specialized Master's accelerated programs. Additionally, qualitative data is needed to explore how enhanced terminology memory aids in clinical field training through patient vignettes and concept mapping research designs. In conclusion, this study

contributes original instructional design principles, supported by cognitive science, that promote the cultivation of expertise among nursing professionals. Further exploration of evidence-based best practices, such as virtual simulation, gamification, and interactive modules, has the potential to enhance existing curricula and benefit individuals and communities that rely on skilled caregivers.

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BIOGRAPHY OF AUTHORS

Barlian Kristanto,
Email: barliankristanto@gmail.com
Orcid ID: https://orcid.org/0009-0009-3071-1405

Bio: Barlian Kristanto is a lecturer in the English Language Education Department at Universitas Harapan Bangsa, Indonesia. He holds a Master's degree in English Language Studies from Sanata Dharma University, which he obtained in 2016. His research interests focus on English for Specific Purposes (ESP), curriculum development, and technology-enhanced language learning. He has contributed to the academic community through the publication of research articles on blended learning, task-based language assessment, and English for nursing. Barlian's teaching experience encompasses both general English courses and the development of ESP courses, with a particular emphasis on English for nursing students. Since 2008, he has been actively involved in teaching as an English instructor and has been recognized for his excellence in research and teaching, receiving research grants and teaching awards. Furthermore, he actively participates in faculty development programs and has been invited to deliver talks at national and international academic events.

Diannike Putri, biography, email and orcid.
Email: dianputei@gmail.com
Orcid ID: https://orcid.org/0009-0002-2985-8935

Diannike Putri is a highly experienced English lecturer with over a decade of teaching experience at the university level. She earned her Master's degree in English Linguistics from Universitas Padjajaran in 2013, following her Bachelor's degree in English Language and Literature from Universitas Negri Yogyakarta in 2010. Her expertise lies in teaching general English courses, English for specific purposes (ESP), and English language teaching (ELT) methodology. Throughout her career, she has taught a wide range of English courses including Beginner English, Business English, English for Nursing, English for Midwifery, TOEFL preparation, and more. In addition to her teaching responsibilities, Ms. Putri actively engages in research within the field of applied linguistics and ELT. She

has published her work in several reputable journals and has presented at notable conferences, focusing on areas such as pragmatic analysis, computer-assisted language learning, English for medical purposes, and reducing foreign language anxiety. Her recent publications have focused on topics such as the satisfaction levels of nursing students in online English learning and the application of semantic analysis to enhance the acquisition of medical terminology. Furthermore, Ms. Putri actively participates in professional development and community outreach activities. She has conducted workshops on English public speaking for high school students, served as a conference moderator, and holds an editorial board membership for the Journal of English Education for Young and Adult Learners. Noteworthy achievements in her career include obtaining registered business status from the Indonesian government in 2022 and securing copyright for a research methodology book in 2023. Additionally, she has co-authored two books; one focusing on intercultural communication and the other on research methodology.

Thanee Glomjai,
Email: thanee@bcnpy.ac.th

Dr. Thanee Glomjai is the Director of the Boromarajonani College of Nursing at Phayao and a faculty member at the Praboromarajchanok Institute in Thailand. He earned his PhD in Nursing from the University of Edinburgh. With over 30 years of experience, Dr. Glomjai's areas of expertise include health promotion, community engagement, nursing leadership and education, border healthcare, and ethnic health promotion. He has presented internationally on primary care, Thai medicine, and community health. His recent publications focus on health promotion for hypertension patients and the integration of folk wisdom into ethnic minority care. Dr. Glomjai extensively contributes to academic literature on nursing and health sciences, and his leadership and scholarship have greatly advanced nursing education and research for community health improvements.