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# Digital Innovation in Radiology Education: Assessing the Impact of Instagram-Integrated Learning for Breast Ultrasound Skill.

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**Summary:** Over a 10-week period, 38 third-year medical students participated in an online course integrated into a basic breast ultrasound workshop. The primary objective of this article is to comprehensively assess the impact of the online self-directed training phase. In the experimental group, students engaged with a curated selection of publicly available audiovisual resources sourced from Instagram®, while the control group followed traditional instruction through conventional masterclasses using PowerPoint presentations. The experimental hypothesis posited that foundational breast ultrasound skills could be effectively acquired through the exploration of public Instagram content combined with self-assessment via Kahoot®. In this context, Kahoot® served not only as the platform for disseminating Instagram-related topics and links but also as a tool for ongoing formative assessments within the experimental group. A quasi-experimental design was employed, incorporating pre- and post-assessments and a control group for comparison. The findings demonstrated significant gains in both knowledge and confidence among students exposed to the gamified, Instagram-based intervention. Specifically, in the domain of Histology and Anatomy, the experimental group improved their post-test scores from 6.68 to 8.68, whereas the control group's scores increased from 4.47 to 5.14. Regarding ultrasound physics knowledge, the experimental group's scores rose from 6.26 to 7.74, in contrast to an increase from 4.17 to 4.90 in the control group. In terms of understanding normal breast anatomy, the experimental group achieved a post-test score of 6.83, while the control group improved from 4.79 to 6.79. Moreover, the experimental group demonstrated a marked improvement in their ability to identify benign and suspicious breast findings. Self-assessment data indicated enhanced confidence in ultrasound skills among experimental group participants, who also reported high levels of enthusiasm for the program, reflected in an average satisfaction rating of 4.63 out of 5. This elevated satisfaction may contribute to increased program visibility and future enrollment. Despite these encouraging results, the limited sample size (19 participants per group) restricts the generalizability of the findings. Future research should involve larger sample sizes and longitudinal designs to better evaluate knowledge retention and the long-term impact of social media platforms on medical education.

**Keywords:** Breast ultrasound; medical education; gamification; social media; Kahoot®; Instagram®, quasi-experimental.

**Resumen:** Durante 10 semanas, 38 estudiantes de tercer curso de medicina participaron en un curso en línea impartido como parte de un taller básico de ecografía mamaria. El objetivo de este artículo es evaluar en profundidad los efectos de la fase de autoformación en línea. En un grupo experimental, estos estudiantes interactuaron con una serie de recursos audiovisuales

meticulosamente comisariados, públicos y de libre acceso desde Instagram®; un grupo de control continuó con la clase magistral tradicional (conferencias en PowerPoint). La hipótesis experimental se centró en el aprendizaje de la ecografía mamaria básica mediante la visualización de material público de Instagram y la autoevaluación a través de Kahoot®; Kahoot® no sólo se convirtió en la plataforma para la entrega de temas y enlaces de Instagram, sino que también contó con autoevaluaciones continuas para el grupo experimental. El estudio empleó un diseño cuasiexperimental con evaluaciones previas y POST-TESTes y grupos de control. El estudio encontró mejoras significativas en el conocimiento y la confianza entre los estudiantes de medicina que utilizan intervenciones gamificadas basadas en Instagram. En conocimientos de histología y anatomía, el grupo experimental aumentó las puntuaciones tras la prueba de 6,68 a 8,68, mientras que el grupo de control mejoró de 4,47 a 5,14. En Física del Ultrasonido, el grupo experimental aumentó su puntaje de 6.26 a 7.74, en comparación con un aumento modesto del grupo de control de 4.17 a 4.90. En comprensión de la Anatomía Normal de la Mama, el grupo experimental alcanzó una puntuación de 6.83, subiendo desde 5.26, mientras que el grupo de control llegó a 6.79 desde 4.79. Además, el grupo experimental mostró avances significativos en la identificación de hallazgos benignos y sospechosos de la mama (de 6.07 a 7.49), mientras que el grupo de control aumentó de 4.52 a 5.63. La autoevaluación indicó una mayor confianza en las habilidades de ultrasonido para el grupo experimental. A pesar de estos hallazgos positivos, el tamaño pequeño de la muestra (19 participantes por grupo) limita la generalización. Se recomienda que futuras investigaciones incluyan cohortes más grandes y diseños longitudinales para evaluar la retención del conocimiento y el impacto de las plataformas de redes sociales en la educación médica, subrayando la creciente aceptación de las redes sociales como herramientas de aprendizaje entre los estudiantes de la Generación Z.

**Palabras clave:** Ecografía mamaria; educación médica; gamificación; redes sociales; Kahoot®; Instagram®, cuasiexperimental.

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## 1. Introduction

On March 10, 2025, the Instagram® account @ctisus_radiology—recognized as a leading resource in radiology education—published a post (figure 1) following a user survey on social media usage for radiology learning. A 2022 poll, answered by 254 participants, revealed that YouTube® was the most widely used platform, preferred by approximately 72% of respondents, followed by Instagram® at 62%. In terms of usage frequency, 46% reported engaging with radiology content daily, while 33% indicated accessing it several times a week. These figures underscore the growing role of social media in engaging younger medical learners and offering accessible alternatives to traditional radiology education.

Instagram® Reels and posts, in particular, provide a visually rich medium well-suited to radiology—a specialty deeply grounded in image interpretation. Despite its promise, the incorporation of edited social media content into formal medical education, especially in radiology, poses challenges concerning accuracy, standardization, and educational validity.

Recent literature supports the educational value of social media in medical training. One publication emphasized how social media platforms enhance surgeons' understanding of procedures and clinical concepts as part of their ongoing professional development. A 2024 systematic review detailed the ways in which surgeons use Facebook®, Twitter®, Instagram®, and YouTube® to connect with peers, discuss complex cases, share knowledge, and provide continuous education unrestricted by geography (1). Furthermore, social media use has been associated with measurable improvements in knowledge, attitudes, and skill acquisition across medical students, residents, and practicing physicians. A particularly notable quasi-experimental study on general surgery residents found that those participating in a Twitter-based educational initiative achieved

greater improvements in American Board of Surgery In-Training Examination percentile ranks compared to their non-participating peers (1).

Given the visual-centric nature of Instagram® and the evolving demographics of today's medical students—largely composed of Generation Z—there is a compelling rationale to investigate the platform's educational potential, particularly in image-intensive fields such as radiology. Generation Z, raised in a technologically dynamic environment, may benefit from innovative educational interventions delivered through familiar digital channels. A study conducted at Sultan Qaboos University demonstrated that Instagram® Reels significantly enhanced anatomy and physiology learning among nursing students (2).

Instagram®'s image-based structure makes it particularly apt for radiology education, where visual interpretation is fundamental. Short video content (Reels) allows for the clear and engaging communication of complex concepts. A systematic review on the use of Instagram in anatomy education outlined effective teaching methods using the platform, including clinical images, explainer videos, multiple-choice questions, and medical illustrations (5). Instagram's features—such as intuitive usability, hashtag-based content organization, and its appeal for visual learning—make it a viable educational tool. Nonetheless, certain limitations persist, including the risk of passive content consumption and the need for qualified personnel to effectively manage educational content (5).

Incorporating breast ultrasound education into social media platforms represents a significant advancement in medical education. This modality is increasingly important in the early and accurate detection of breast cancer. Breast ultrasound is a non-radiative, cost-effective imaging method that complements mammography. Today, ultrasound is increasingly recognized by medical students as an essential diagnostic tool—not only by radiologists, but also by practitioners across various specialties.

Recent studies highlight the growing adoption of point-of-care ultrasound (POCUS) in diverse clinical settings beyond emergency medicine. As POCUS use expands, so does the need for comprehensive training in ultrasound image interpretation to enhance diagnostic precision and patient care (6). Proper training improves diagnostic accuracy and ultimately leads to better clinical outcomes. The integration of ultrasound into multiple medical specialties reflects a shift toward more immediate and informed decision-making in clinical practice. A 2022 survey revealed that over half of U.S. medical schools had incorporated POCUS training into their undergraduate medical education curricula (9), underscoring the increasing recognition of ultrasound's value in both education and clinical care.

*¿How Social Media Content Improves Online Learning?*

For members of Generation Z—preclinical medical students who are true digital natives—learning ultrasound through curated social media content offers an engaging, interactive experience. A recent evaluation explored the use of Instagram® as a tool for ultrasound and radiology education. While educational ultrasound posts were relatively scarce (constituting only 11% of analyzed content), nearly 50% of posts tagged with "#radiology" were deemed educational. The strategic use of hashtags such as "#UltrasoundEd" significantly increased the visibility and accessibility of educational content. These findings support the conclusion that Instagram, when optimized through purposeful tagging, can be an effective platform for disseminating image-based medical education and improving content discoverability for learners (7).

The adaptability of social media in complementing ultrasound education is further supported by studies involving platforms such as Facebook®, which offer a variety of communication tools aimed at enhancing knowledge retention and learner engagement (8–10). These tools align closely with the learning preferences of Generation Z students, who favor straightforward, visual, and

interactive educational resources. The increasing reliance of younger generations on social media for both communication and education reflects a broader shift in learning habits. A 2024 study demonstrated that Generation Z medical students prefer multimedia resources over traditional textbooks. The study concluded that visuals—such as clinical demonstration videos—were more effective than text in conveying complex topics, including cardiovascular and neurological examinations (14).

Supporting these findings, a 2020 study revealed that Gen Z nursing students spend an average of 1.37 hours per day using social media for clinical learning, with YouTube® and Google+/Currents among their most utilized platforms (13). A 2025 survey among medical residents found Instagram® to be the most frequently used platform during the residency application process, with 47.5% of respondents engaging with it. Remarkably, Instagram influenced 26.2% of students' residency rankings and shaped the program perceptions of 47.6% of respondents (12). Instagram's appeal stems from its ability to merge educational content with insights into residency culture, faculty interactions, and social events, fostering a strong sense of community among medical students. Students increasingly favor educational content that blends social connection with academic enrichment. Creative posts that integrate community-building elements with instructional content are especially impactful. A 2021 study emphasized Instagram's usefulness in helping students explore medical career pathways, including specialties such as orthopedic surgery (15–16). By facilitating access to educational materials, imaging techniques, and narratives from clinical practice, Instagram enhances both learning and career exploration for aspiring physicians.

In 2022, Premal Patel identified two key considerations for addressing Generation Z's expectations in medical education (17):

- Curricular Innovation: Medical education must evolve to meet the needs of Gen Z learners by incorporating methods such as team-based learning, problem-based learning, and flipped classrooms, both online and in-person.

- Content Design: Educational content should be concise, engaging, and tailored to short attention spans. Multimedia and visual aids should be prioritized to improve understanding and retention.

This research project investigated the feasibility of using a digital, audiovisual, social media-based approach to teach breast ultrasonography to undergraduate medical students. The broader goal was to innovate educational strategies for training future healthcare providers in the early identification of breast diseases, thereby improving their competency in ultrasound interpretation. This initiative addresses gaps in early breast cancer detection—a critical area within the healthcare system—and proposes new methodologies to enhance diagnostic accuracy and patient outcomes.

Over a 10-week period, 38 third-year medical students participated in an online course embedded within a basic breast ultrasound workshop. This article aims to evaluate in depth the effects of the online self-training phase. In the experimental group, students engaged with a collection of publicly available and carefully selected audiovisual resources sourced from Instagram®, while the control group received conventional instruction through PowerPoint-based masterclasses. The central hypothesis of the study posits that students can acquire foundational breast ultrasound skills by analyzing openly accessible Instagram content and participating in self-assessment through the Kahoot® platform.

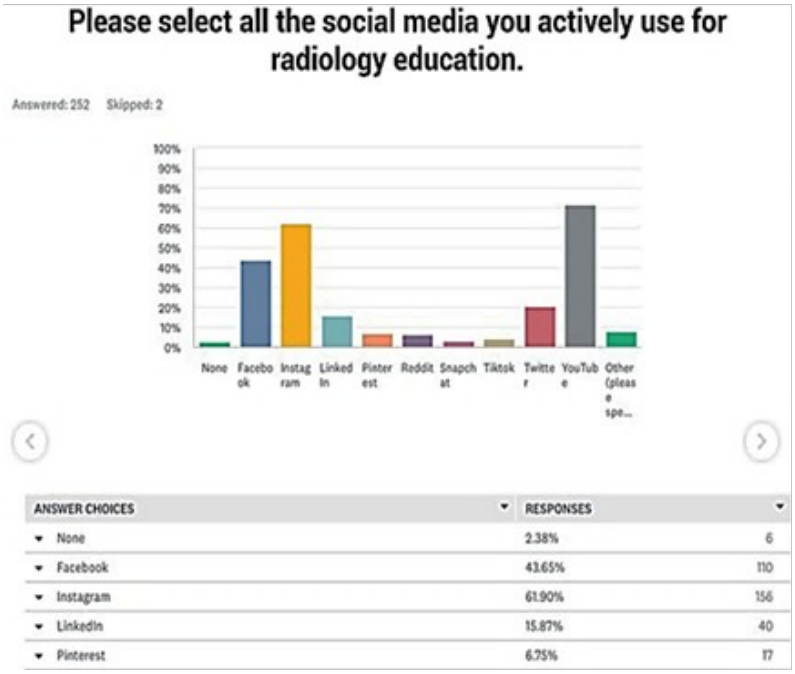


**Figure 1.** Survey conducted by @ctisus_radiology. The survey assesses the primary social media platforms and the frequency with which users engage to acquire knowledge in radiology. https://www.instagram.com/p/DHBKV-jMbS7/

## 2. Methods

*Scope and duration*

The duration of the project was five months (table 1). This research initiative was designed to align with the educational strategies of the medical school by integrating online radiology training for third-year medical students, with a particular emphasis on basic breast ultrasound education. To achieve this goal, an online course was developed, featuring curated educational content sourced from Instagram®. Online learning serves as a valuable pedagogical tool, promoting the development of critical, creative, and complex thinking skills (14). It offers flexibility, allowing students to engage with learning materials at their convenience, while still participating in structured online educational activities that support deep and comprehensive understanding (20). In the context of this project, online learning was employed to teach and demonstrate foundational ultrasound skills, specifically focused on breast ultrasound interpretation.

*Requirements:*

- Online Component: The intervention integrated multimedia elements including posts (Figure 2), short videos in the "Reels" format (Figure 3), animations, quizzes, and interactive cases (20). This study utilized only publicly accessible, curated Instagram® content—available without cost, registration, or the requirement to follow specific accounts. Figure 2 provides an example of such content.

- Technology Integration: The intervention leveraged technology to support adaptive learning (20). The online format incorporated a Kahoot®-based course structure, which included interactive quizzes aligned with Instagram® content.

*Study Design*

This was a quasi-experimental, pre- and post-test design with a control group. The rationale for using a quasi-experimental approach in this educational study, which assessed Instagram® as a tool for teaching breast ultrasound to undergraduate medical students, is multifold:

1. It enables the evaluation of interventions in real-world educational settings, thereby improving external validity.
2. It offers a practical alternative when randomization is constrained. However, in this case, randomization was achieved based on diagnostic test ranking within the full participant sample.
3. It provides a cost-effective way to evaluate the impact of innovative tools such as social media in medical education.
4. It is feasible within the context of medical education, where digital learning platforms are increasingly integrated.
5. It allows for the exploration of how platforms like Instagram® influence engagement and learning in image-intensive subjects such as ultrasound.

*Advantages of the Quasi-Experimental Design*

- Ecological Validity: Facilitates research in real-world settings, increasing the external validity of the findings (26).
- Practicality: Appropriate when randomization is impractical or unethical, while still enabling intervention testing in authentic conditions (26).
- Cost-Effectiveness: Requires fewer resources than randomized controlled trials (24).
- Longitudinal Feasibility: Can support research tracking outcomes over time (25).

*Limitations of the Quasi-Experimental Design*

- Lower Internal Validity: Without full randomization, controlling for all confounding variables is more challenging (26).
- Limited Causal Inference: Makes drawing definitive cause-and-effect conclusions more difficult (25).
- Selection Bias: Non-random group assignment may introduce bias (22).
- Data Quality Issues: Retrospective data collection can lead to missing, inaccurate, or incomplete data (24).

*Inclusion and Exclusion Criteria*

Participation was restricted to third-year medical students and was designed as a voluntary, optional complement to the existing university curriculum. No academic credit or financial compensation was provided, and anonymity was preserved to ensure no impact on participants' academic evaluations. A cap of 40 students was set for the study. Out of 45 initial respondents, 38 met the inclusion criteria, reflecting a rigorous and standards-based recruitment process. The inclusion criteria were:

- Enrollment as a third-year medical student.
- Completion of the General Radiology rotation in the preceding semester.
- Understanding that Instagram® content is publicly available and does not require account creation or following specific profiles.
- Willingness to participate in weekly Kahoot® quizzes, engage with Instagram® content, and complete both pre- and post-tests.
- Provision of informed consent.

And the exclusion criteria were:

- Students from other academic years or non-medical programs.
- Failure to complete the third-year General Radiology rotation.
- Refusal to engage with Instagram® content.
- Incompatibility with online participation, as indicated on the recruitment form.
- Refusal to provide informed consent.

*Random assignment*

To minimize systematic bias, participants were randomly assigned to the control or experimental group following an initial diagnostic test administered anonymously via www.exam.net. This test, based on validated items from a pilot survey, evaluated fundamental knowledge of ultrasound physics, image formation, breast anatomy, histology, and pathology (both benign and malignant). Participants were then sorted in ascending order of their scores and distributed randomly across both groups to ensure a balanced range of baseline knowledge.

*Improving validity and minimizing bias*

This method helped ensure that observed effects were attributable to the intervention itself, rather than extraneous factors. Instagram® engagement, while measured, was not assumed to correlate with academic performance, serving instead as an instrumental variable to isolate the impact of the intervention. The use of pre-intervention diagnostic tests confirmed baseline equivalency between groups, strengthening the internal validity and reducing the variability that might obscure true effects.

*Use of Non-Equivalent Dependent Variables*

To further support the study's validity, outcome assessments included more than just knowledge acquisition. A post-intervention Likert scale survey measured student satisfaction with the course design and Instagram® content, treating satisfaction as a secondary outcome rather than a driver of academic gains.

*Blinding in Evaluation*

All evaluations were conducted in a neutral and anonymous manner. Student assessors were unaware of participants' group assignments, minimizing evaluator bias. This quasi-experimental, pre-post test framework helped ensure methodological rigor and strengthened the validity of the study's conclusions.

*Data analysis*

IBM 29th ed. SPSS. was used to run descriptive and inferential statistics. Descriptive statistics include the mean and standard deviation. Inferential statistics include two major tests, namely independent samples T-test (Student´s T test) and paired sample T-test. For comparing the control and experimental groups, the independent samples were used. For the pre and posttest scores, the paired sample T-test is used to check whether or not there is a statistically significant improvement in the test scores due to the intervention or experiment that is implemented. As a follow-up satisfaction survey, it was assessed through a comprehensive descriptive analysis derived solely from the experimental group at the end of the intervention.

**Table 1.** Schedule of operations across the five-month research period, encompassing pilot study, content curation, diagnostic assessment, pre- and post-intervention evaluations, and subsequent evaluation analysis and statistical analysis.

| 2024 Stages | February | March | April | May | June |
|---|---|---|---|---|---|
| Pilot Study – Questionaries Validation | | | | | |
| Content Curation | | | | | |
| Building The Digital Interface - Kahoot Course | | | | | |
| Volunteer Recruitment Phase | | | | | |
| Study Instruction Phase. Diagnostic Test (Pre-Test) | | Diagnostic Test (Pre-Test), Randomize Groups Using Ranking | | | |
| Experimental: Social Media Exposure. Control: Traditional Classrooms. | | | | Final Evaluation (Post-Test) | |
| Evaluation Phase | | | | | |
| Results Interpretation Phase | | | | | |
| Statistical Analysis | | | | | |

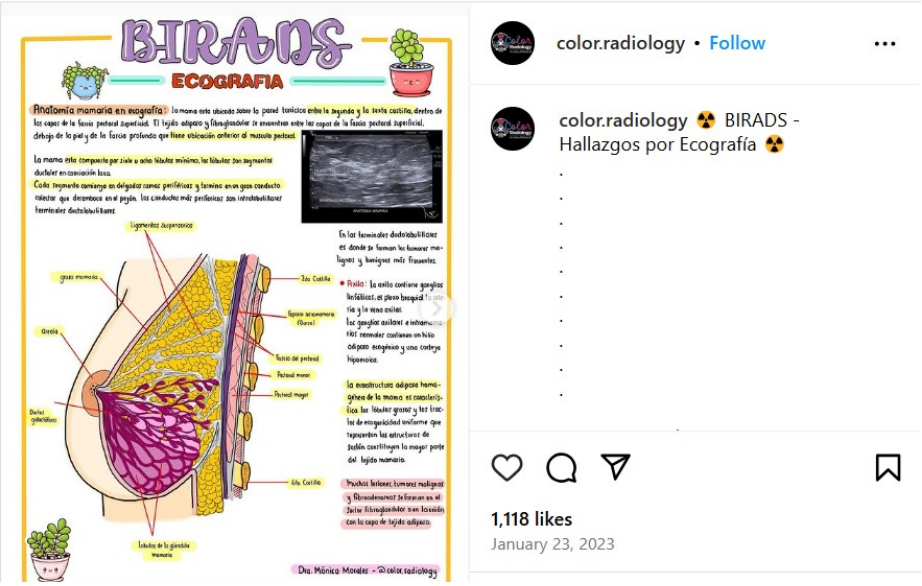


**Figure 2.** For Spanish-speaking students, this curated post, which includes images and diagrams, was utilized. Consequently, it is written in Spanish. This is an example of a public post in Instagram (18). Fuente: Morales, M. (s. f.). *BIRADS - Hallazgos por Ecografía*. Instagram. https://www.instagram.com/p/CnwqifxOhYt/

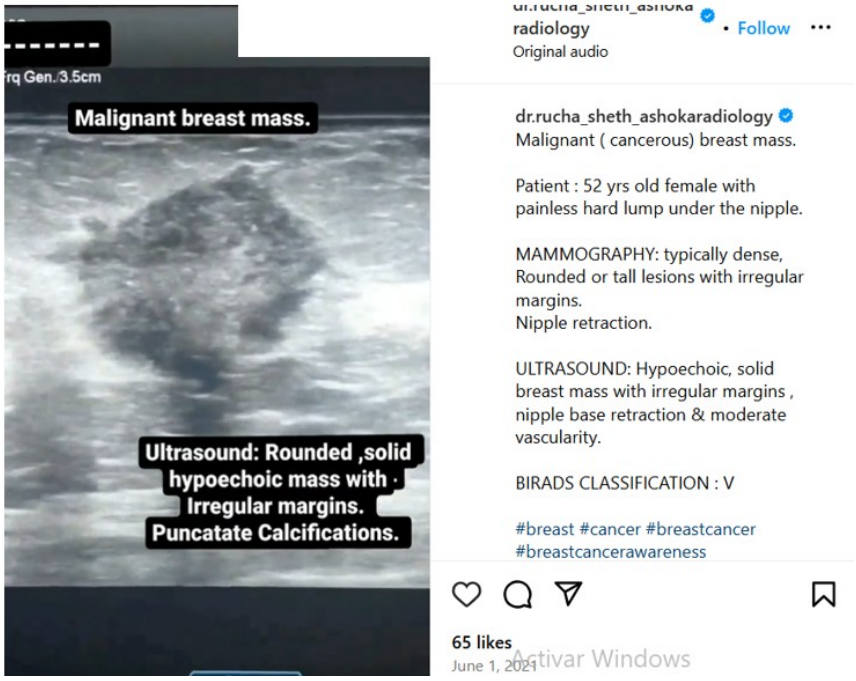


**Figure 3.** This an example of an explicative short video (Reel), explaining a case with suspicious features (19). Source: Sheth Ashoka, R. (2021, June 1). Malignant (cancerous) breast mass [Reel]. Instagram. https://www.instagram.com/reel/CPlJt-KhFWR/

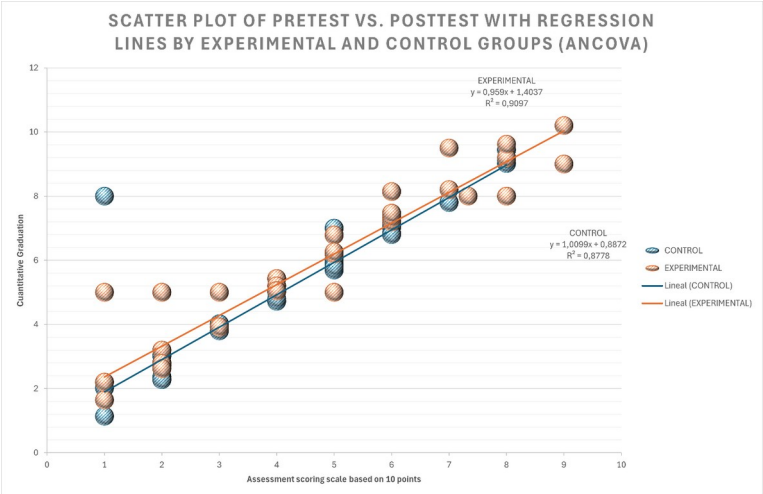


**Figure 4.** Scatter Plot of Pretest vs. Posttest with Regression Lines by Experimental and Control Groups (ANCOVA).

*Internal validity*

This study aimed to assess breast ultrasound knowledge using a 20-question multiple-choice questionnaire developed as a pilot instrument. The questionnaire was designed to evaluate knowledge across four key domains:

- Basic ultrasound physics and image interpretation.
- Anatomy and histology of the mammary gland.
- Benign breast diseases.
- Suspicious findings in breast ultrasound.

To validate the instrument, eight breast ultrasound experts—board-certified radiologists—completed the questionnaire on two separate occasions, spaced one to two weeks apart (table 2). Their responses were analyzed to determine internal consistency, temporal stability, and inter-rater reliability using the following statistical methods: Cronbach's alpha, Pearson correlation, and the Intraclass Correlation Coefficient (ICC).

*Internal Consistency*

To evaluate internal consistency, Cronbach's alpha was calculated. The resulting value was 0.810, indicating good reliability. This suggests that the items on the questionnaire consistently measure the intended underlying constructs of breast ultrasound knowledge.

*Inter-Rater Reliability*

A two-way mixed-effects model was used to calculate the Intraclass Correlation Coefficient (ICC) for average measures. The ICC was 0.810, with a 95% confidence interval ranging from 0.052 to 0.962. The F-test yielded statistically significant results: $F(7, 7) = 5.267$, $p = .022$, indicating reliable agreement among expert raters across both testing occasions.

*Temporal Stability*

Pearson correlation analysis was conducted to assess the stability of scores over time. The correlation coefficient between the two test administrations was $r = 0.689$, with a p-value of 0.05. This result indicates a moderate to strong positive relationship between scores, suggesting that experts who performed well on the first attempt tended to perform similarly on the second attempt, confirming the test's temporal reliability.

In summary, the pilot questionnaire demonstrated solid psychometric properties, including strong internal consistency, reliable inter-rater agreement, and stable performance over time. These findings support its use as a valid and reliable tool for assessing breast ultrasound knowledge in future educational interventions.

*Methodological plan*

This research initiative was introduced to third-year medical students on a voluntary basis, highlighting its role within an educational study focused on radiology. Information about the study and its organization—including an online training component in basic breast ultrasound delivered via social media—was disseminated through academic announcements and digital platforms at the University. A total of 54 third-year medical students initially expressed interest in participating. After applying the inclusion and exclusion criteria, the final sample size consisted of 38 students, divided equally between an experimental group (n = 19) and a control group (n = 19). The study was conducted in three distinct phases:

1. Pre-Study Phase (Week 1): All participants completed a diagnostic pre-test. Based on the anonymous ranking of scores, students were randomly assigned to either the experimental or control group, following a quasi-experimental design.
2. Intervention Phase (Weeks 2 to 8): The experimental group engaged with structured content organized by thematic chapters. This included audiovisual resources curated from public Instagram® accounts and weekly interactive quizzes via Kahoot®. In contrast, the control group continued with traditional instruction, consisting of unidirectional lectures delivered through PowerPoint presentations.
3. Post-Exposure Phase (Weeks 8 to 11): Both groups completed a post-test using the same validated questionnaire employed in the pre-test. Additionally, students in the experimental group were invited to complete a satisfaction survey assessing their experience with the Instagram®-based teaching method at the conclusion of the course.

*Ethical aspects.*

This study was reviewed and approved by the Ethics and Research Committee of the University of Murcia prior to its implementation. The following ethical principles were adhered to throughout the study:

- Confidentiality: Participation was anonymous; no authentication or login was required for assessments.
- Data Protection: All data—both results and personal information—were encrypted to ensure privacy.
- Non-remuneration: Participants did not receive any financial or academic compensation for their involvement.
- Self-funding: The project was entirely self-funded by the research team, with no external sponsorship.
- No Commercial Interest: There was no requirement to create or follow any Instagram® accounts. All educational materials used in the study were freely accessible public content, available to both account holders and non-users.

**Table 2.** The results from the pretest and post-test MCQ surveys demonstrated that eight medical radiologists responded to the same questionnaire at intervals of one to two weeks.

**PRETEST**

| Expert | P1 | P2 | P3 | P4 | P5 | P6 | P7 | P8 | P9 | P10 | P11 | P12 | P13 | P14 | P15 | P16 | P17 | P18 | P19 | P20 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 15 |
| E2 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 16 |
| E3 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 14 |
| E4 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 15 |
| E5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 16 |
| E6 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 14 |
| E7 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 17 |
| E8 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 17 |

| Expert | Score Pretest |
|---|---|
| E1 | **15** |
| E2 | **16** |
| E3 | **14** |
| E4 | **15** |
| E5 | **16** |
| E6 | **14** |
| E7 | **17** |
| E8 | **17** |

**POSTEST**

| Expert | P1 | P2 | P3 | P4 | P5 | P6 | P7 | P8 | P9 | P10 | P11 | P12 | P13 | P14 | P15 | P16 | P17 | P18 | P19 | P20 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 16 |
| E2 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 17 |
| E3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 17 |
| E4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 19 |
| E5 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 19 |
| E6 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 16 |
| E7 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 19 |

## 3. Results

*Statistical Analysis and Results*

This analysis evaluated differences in post-intervention scores between the experimental and control groups (figure 4). Analysis of Covariance (ANCOVA) was employed to determine the effect of the intervention while adjusting for baseline differences in pretest scores.

The results indicate a significant effect of the intervention. The regression equation for the experimental group was $y = 0.959x + 1.4037$, with a coefficient of determination ($R^2$) of 0.9097. For the control group, the equation was $y = 1.0099x + 0.8872$, with an $R^2$ of 0.8778.

These findings suggest that for every one-point increase in the pretest score, posttest scores increased by approximately 0.96 points in the experimental group and 1.01 points in the control group. The similarity in slope values (0.959 and 1.0099) demonstrates that both groups followed nearly parallel trends in posttest performance relative to pretest scores. This confirms that the assumption of homogeneity of regression slopes—a key requirement for ANCOVA—was met.

The regression intercepts provide further insight. While a pretest score of zero is not practically meaningful, the intercepts reflect the vertical shift between regression lines: +1.4037 for the experimental group and +0.8872 for the control group. After adjusting for pretest scores, these differences suggest that the experimental group outperformed the control group on the posttest.

The high $R^2$ values (0.9097 and 0.8778) for both groups indicate that the linear regression model explained a substantial proportion of the variance in posttest scores. These values, both exceeding 0.87, highlight the model's strong explanatory power and reinforce the appropriateness of ANCOVA for this study.

The ANCOVA revealed a statistically significant difference between groups after adjusting for pretest scores, with a p-value of 0.0196. The 95% confidence interval for the difference in posttest scores between groups ranged from 0.07 to 0.75, favoring the experimental group.

In summary, the intervention had a clear and statistically significant positive effect on participants' posttest performance. These findings support the effectiveness of using curated Instagram® content as a complementary educational tool and provide a solid foundation for future research in digital learning strategies within medical education.

*Comparative analysis*

Table 2 presents a comparative analysis of the average scores obtained by both the experimental and control groups in relation to the breast ultrasound learning outcomes. The data indicate that the experimental group, which received Instagram®-based online training, achieved higher average scores compared to the control group, suggesting the positive impact of the digital intervention on students' learning performance.

**Table 2.** Independent Data And Average Ratings In Each Learning Area.

| Subjects Of The Online Training (Pre And Post Test) | Groups | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Histology And Normal Anatomy (Previous) | Control | 19 | 4.47 | 1.679 | .385 |
| | Case | 19 | 6.68 | 3.038 | .697 |
| Histology And Normal Anatomy (Post-Test) | Control | 19 | 5.14 | 1.438 | .330 |
| | Case | 19 | 8.68 | 1.322 | .303 |
| Physical Principles Of Ultrasound (Previous) | Control | 19 | 4.17 | 1.330 | .305 |
| | Case | 19 | 6.26 | 1.821 | .418 |
| Physical Principles Of Ultrasound (Post-Test) | Control | 19 | 4.90 | 1.300 | .298 |
| | Case | 19 | 7.74 | 1.731 | .397 |
| Ultrasound Anatomy Of The Normal Breast (Previous) | Control | 19 | 4.79 | 1.619 | .371 |
| | Case | 19 | 5.26 | 1.628 | .373 |
| Ultrasound Anatomy Of The Normal Breast (Post-Test) | Control | 19 | 6.79 | 1.200 | .275 |
| | Case | 19 | 6.83 | 1.278 | .293 |
| Ultrasound Of Benign And Malignant Breast Findings (Previous) | Control | 19 | 4.52 | 0.991 | .227 |
| | Case | 19 | 6.07 | 1.404 | .322 |
| Ultrasound Of Benign And Malignant Breast Findings (Post-Test) | Control | 19 | 5.63 | 1.143 | .262 |
| | Case | 19 | 7.49 | 1.486 | .341 |

Table 3 presents the differences in knowledge acquisition between the experimental (case) and control groups during the pre-test and post-test phases. The findings reveal a statistically significant difference between the groups, with a 95% confidence interval, highlighting the effectiveness of the educational intervention.

**Table 3.** Variations in the acquisition of knowledge between experimental and control groups during the pre-test and post-test phases.

| | | Paired Differences | | | | | t | Significance | |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean Pre-Post. | Std. Dev. | Std. Error | 95% Confidence Interval | | | One-Sided p | Two-Sided p |
| | | | | | Lower | Upper | | | |
| Pair 1 | Histology and normal anatomy | -1.331 | 1.829 | .297 | -1.932 | -.730 | -4.485 | <.001 | <.001 |
| Pair 2 | Physical principles of ultrasound | -1.103 | 1.018 | .165 | -1.437 | -.768 | -6.676 | <.001 | <.001 |
| Pair 3 | Ultrasound anatomy of the normal breast | -1.786 | 1.171 | .190 | -2.171 | -1.401 | -9.398 | <.001 | <.001 |
| Pair 4 | Ultrasound of benign and malignant breast findings | -1.266 | .829 | .135 | -1.539 | -.994 | -9.412 | <.001 | <.001 |

The impact of skill acquisition in breast ultrasound on self-perception was evaluated between the experimental and control groups during the pre-test and post-test phases. The analysis revealed statistically significant differences among the six paired groups (table 4). A survey was conducted at the end of the online training to assess student satisfaction with this educational method (table 5).

**Table 4.** Impact of Self-Perception on Skill Acquisition in Breast Ultrasound between experimental (cases) and control group during the pre- and post-test phases.

| | | Paired differences | | | | | t | Significance | |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean | Std. Dev. | Std. Error | 95% confidence interval | | t | One-sided p | Two-sided p |
| | | | | | Lower | Upper | | | |
| Pair 1 | At this time. I can identify better ultrasound physics (artifacts and echogenicity) more clearly. | -1.553 | 1.142 | .185 | -1.92 | -1.177 | 8.379 | <.001 | <.001 |
| Pair 2 | I have a better understanding of how to use the ultrasound machine. | -1.484 | 1.299 | .211 | -1.91 | -1.057 | 7.042 | <.001 | <.001 |
| Pair 3 | I am able to identify in a better way the normal breast anatomy and histology by ultrasound. | -1.616 | 1.043 | .169 | -1.92 | -1.273 | 9.547 | <.001 | <.001 |
| Pair 4 | I can adequately identify benign findings of breast lesions. | -1.921 | 1.160 | .188 | -2.302 | -1.540 | 10.2 | <.001 | <.001 |
| Pair 5 | I can adequately identify malignant findings of breast lesions. | -1.747 | 1.087 | .176 | -2.15 | -1.390 | 9.911 | <.001 | <.001 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Pair 6 | I can hypothesize birads categories by ultrasound. | -1.634 | 0.995 | .161 | -1.90 | -1.307 | 10.1 | <.001 | <.001 |

**Table 5.** Degree of satisfaction among students regarding this methodology and its components throughout the workshop.

| | **Mean** | **Std. Deviation** |
|---|---|---|
| The imparted Instagram links. Did they provide you with useful information to solve this Kahoot? | 4.42 | .769 |
| Usefulness perception social media in radiology | 4.21 | 1.134 |
| You are satisfied with the Kahoot evaluation format. | 4.26 | .872 |
| How do you consider studying ultrasound cases through Post/short Reel-videos? These materials are useful for radiology. | 4.37 | 1.065 |
| Are you satisfied with the use of this modality (post/reels) to study radiology. | 4.26 | 1.098 |
| Would you recommend this course to someone who needs to improve their knowledge of ultrasound and breast ultrasound? | 4.63 | .496 |
| In general terms, how would you rate the entire course. | 4.63 | .496 |
| Would you recommend the use of this audiovisual material in radiology to your teachers. | 4.37 | .955 |

## 4. Discussion

*Analysis of Knowledge Acquisition in Breast Ultrasound Between Experimental and Control Groups*

In the current quasi-experimental study, which included both a control group and an experimental group (case), the results in table 2 provide a comparative analysis of the four chapters evaluated by pre- and post-tests. These results highlight how the intervention, which used Instagram® content in a gamified format, contributed to the students' knowledge acquisition related to ultrasound interpretation. The key findings were:

1. Histology and Anatomy: The intervention aimed at increasing knowledge in histology and anatomy showed notable improvements in the experimental group.
    1. Pre-test Scores: The case group scored significantly higher, with a mean of 6.68 (SD = 3.038), compared to the control group, which had a mean of 4.47 (SD = 1.679).
    2. Post-test Scores: The control group showed some improvement, reaching a mean of 5.14 (SD = 1.438), while the case group showed a more substantial increase, with a mean score of 8.68 (SD = 1.322).
2. Physical Principles of Ultrasound: The gamified strategy using Instagram material helped improve students' understanding of the physical principles of ultrasound.
    1. Pre-test Scores: The experimental group scored 6.26 (SD = 1.821), while the control group had a mean of 4.17 (SD = 1.330).
    2. Post-test Scores: The experimental group achieved a mean score of 7.74 (SD = 1.731), while the control group showed a smaller improvement, reaching a mean score of 4.90 (SD = 1.731).
3. Ultrasound Anatomy of the Normal Breast: Both groups improved in their understanding of ultrasound anatomy of the normal breast, though the intervention's impact appeared less pronounced here.
    1. Pre-test Scores: The case group scored 5.26 (SD = 1.619), and the control group had a mean score of 4.79 (SD = 1.619).
    2. Post-test Scores: The experimental group scored 6.83 (SD = 1.200), and the control group showed a slight increase to 6.79 (SD = 1.200).

4. Benign and Suspicious Breast Findings via Ultrasound: The intervention had a significant impact on the knowledge of benign and suspicious breast findings, with the experimental group showing the greatest improvement.
    1. Pre-test Scores: The case group scored 6.07 (SD = 1.404), while the control group had a mean of 4.52 (SD = 0.991).
    2. Post-test Scores: The case group achieved a mean of 7.49 (SD = 1.486), while the control group improved to 5.63 (SD = 1.143).

This comprehensive analysis underscores the effectiveness of the intervention in enhancing knowledge across various domains of medical education, particularly in histology and ultrasound. The experimental group consistently demonstrated significantly better scores across all evaluated areas when compared to the control group. The statistical significance of the differences between groups suggests that the intervention had a positive impact on knowledge acquisition. The use of a quasi-experimental design—despite being limited by the lack of randomization—was effective in evaluating the success of the intervention in a real-world educational setting. The integration of social media platforms like Instagram, along with gamification, contributed significantly to the improvement of students' understanding of complex topics in breast ultrasound and histology.

The results align with modern teaching principles that support the use of interactive and participative approaches, particularly in the context of medical education. In conclusion, the data in Table 3 further demonstrates that the experimental group, which participated in the online training, achieved significantly better scores than the control group across all domains. The post-test results highlighted significant improvements in participants' knowledge, reinforcing the effectiveness of gamification and Instagram content in enhancing learning outcomes. This study contributes to the growing body of evidence supporting the use of innovative teaching methods—particularly social media—in medical education.

*Impact of Gamified Instruction Using Instagram® on Self-Perception of Breast Ultrasound Skills*

Table 4 illustrates significant changes in participants' self-assessment of their breast ultrasound skills following a quasi-experimental instructional intervention. This study specifically contrasts the outcomes of a control group with those of an experimental group that underwent the intervention. The key findings show that all paired comparisons between pre-test and post-test scores for both groups demonstrated statistically significant changes, indicating that the intervention prompted meaningful changes in participants' self-evaluation of their ultrasound abilities. The key findings were:

1. Self-Assessment Improvement:
    1. The experimental group demonstrated marked increases in self-perceived skills. For example, the group's knowledge of ultrasound physics improved significantly, with a mean difference of -1.553, signaling a noteworthy and statistically significant change rather than a random fluctuation.
    2. Other evaluated skills—operation of sonographer machines, identification of normal anatomy, and recognition of benign and malignant findings—also showed significant improvements. Specifically, the experimental group's ability to identify benign findings exhibited the largest mean difference of -1.921, indicating a considerable enhancement in this skill set.
2. Gamification and Instagram® Content: The intervention, which incorporated gamification and Instagram® content, proved highly effective in improving students' self-perception of their ultrasound skills. These findings support contemporary research advocating for the use of innovative teaching methodologies, such as multimedia and interactive materials, to enhance learning outcomes in medical education.
3. Satisfaction with Social Media and Gamification:

    1. Participants reported high satisfaction with the Instagram®-based instructional method. The average score of 4.42 for the use of Instagram® links reflected students' positive opinions about social media as an educational tool.
    2. Students also rated social media's relevance in radiology with an average score of 4.21, further emphasizing their preference for such platforms in educational contexts.
    3. The Kahoot® evaluation system received an average score of 4.26, indicating strong engagement and positive feedback on its effectiveness in fostering interactive learning.
4. Audiovisual Methods and Reels:
    1. The use of Instagram® "Reels" (short-form videos) for teaching ultrasound was well-received, with a mean score of 4.37, reflecting how these audiovisual methods enhance the teaching process.
    2. The overall satisfaction score of 4.63 further highlighted the effectiveness of the program in engaging students and fostering confidence in their ability to teach others, as reflected in the high mean score for directing others (4.63).

This study contributes to the growing body of literature on the use of Instagram® as a teaching tool in medical education. In contrast to other studies, such as the 2021 study on Instagram® in a hematology and oncology curriculum, where 72.6% of medical students showed engagement by creating Instagram accounts specifically for the program, this study emphasizes Instagram®'s effectiveness in enhancing comprehension and student involvement in visually intensive fields like ultrasound. Instagram® was found to significantly improve comprehension of complex topics and foster student engagement, particularly through clinical practice posts, self-care tips, and mnemonics, which resonate strongly with students. In conclusion, the gamified Instagram® intervention demonstrated clear educational benefits in improving self-perception of ultrasound skills among medical students. With high satisfaction rates, particularly regarding the use of social media and interactive evaluation tools, the intervention was successful in fostering a more engaging and effective learning environment. These findings underscore the growing potential of social media platforms, such as Instagram®, in medical education—particularly in enhancing skills in complex, visually demanding fields like breast ultrasound.

*Instagram in Medical Education: Enhancing Learning and Engagement*

Recent studies have highlighted the effectiveness of Instagram® as a tool for enhancing medical education, particularly in fields requiring strong visual and interactive learning methods.

The 2025 Study: "Instagram as a Tool to Enhance Human Histology Learning", demonstrated the efficacy of a dedicated Instagram account in improving human histology learning. The account featured interactive materials, histology images, and quizzes. The study involved second-year medical students, and findings showed that 85.6% of students actively engaged with the content. Notably, students who engaged more frequently had significantly better exam outcomes. The study emphasizes that Instagram's visual and interactive nature enhances knowledge retention and student engagement in histology education, highlighting its potential as a supplementary resource within medical curricula.

The 2023 Study: "Engagement with a Medical Student Life Instagram Account", analyzed an undergraduate medical student life account, which focused on student experiences, wellness initiatives, and academic resources. The study revealed substantial participation and engagement from medical students, underscoring Instagram's role in fostering community and disseminating important instructional information. It demonstrates how Instagram can be used to connect students, promote wellness, and offer an engaging platform for sharing educational content.

The 2023 Study: "Evaluating the Effectiveness of Instagram as a Health Education Tool" explored Instagram's potential as a medium for health education, highlighting its accessibility and aesthetic appeal. The study concluded that Instagram's interactive features make it an ideal

platform for spreading educational resources to healthcare students, reinforcing the idea that social media can be a powerful tool for engagement and learning in medical education.

The 2020 Study: "InstaHisto: Utilizing Instagram as a Medium for Disseminating Visual Educational Content" focused on Instagram® accounts dedicated to histology education, yielding impressive results. 98% of participants found the platform user-friendly, while 95% reported that the content on Instagram enhanced their confidence in responding to histology test questions. Additionally, 75% of participants indicated that using Instagram helped relax them during their histology studies. These findings suggest that the integration of Instagram® into educational frameworks can improve student engagement and learning outcomes by making the study process more enjoyable and less stressful.

*Limitations and Future*

While these studies highlight the potential of Instagram as an effective tool in medical education, several limitations must be acknowledged:

- Sample Size Limitations: The studies, including the current research, involved relatively small sample sizes (e.g., 19 participants per group). While these findings are valuable, they may not be fully generalizable to larger populations. Future research should consider larger sample sizes to enhance the credibility and applicability of the results.
- Pre- and Post-Test Design Issues: The pre- and post-test design is subject to several biases, including the potential familiarity effect. Participants may perform better in the post-test simply because they are more familiar with the test format, rather than because of an actual improvement in knowledge. To address this, future studies could use longitudinal designs with multiple sequential assessments to evaluate knowledge retention over time, rather than relying solely on one-time tests.
- Exploration of Teaching Methods: There is a need for more research on teaching methods in medical education, particularly with regard to their effects on students' persistence, enthusiasm, and knowledge retention. The use of Gamification in medical education has shown promise, and future studies should explore how game-based learning compares with traditional teaching methods. By examining different teaching approaches, we can identify the most effective methods for improving critical thinking skills in medical education.
- Self-Perception and Clinical Performance: Future research could also investigate how self-perception of students' abilities influences their clinical performance. Understanding how students perceive their skills, including their confidence in their abilities, can provide valuable insights into the impact of educational interventions on real-world medical practice. The role of self-confidence in clinical performance should be explored to determine how it affects decision-making and patient care.
- Integration of Technology: With the increasing role of technology in education, future studies should explore how virtual reality, social media, and online learning platforms can be integrated into medical training. Combining interactive technologies with traditional learning could enhance medical education and create a more engaging and effective learning experience for students.

The studies reviewed suggest that Instagram® is an effective tool for enhancing medical education, particularly in fields requiring strong visual and interactive learning. Instagram®'s engagement potential, combined with gamification, interactive quizzes, and visual content, proves effective in improving students' self-perception, knowledge retention, and overall learning outcomes. However, future research should focus on expanding sample sizes, addressing test biases, and exploring longitudinal assessments. There is a promising future for integrating social media and interactive technologies into medical education to improve student engagement, confidence, and clinical performance.

## 5. Conclusions

- This study highlights the potential of using Instagram-based gamified content as an educational tool in the radiology field. Despite some limitations, particularly the small sample size, the quasi-experimental design provides strong evidence of the positive impact of this intervention on both cognitive growth and students' self-assessment of ultrasound skills. The study demonstrates that social media platforms, when incorporated into educational strategies, can effectively enhance learning outcomes in complex medical subjects.
- The results emphasize the effectiveness of Instagram-based interventions in improving knowledge acquisition. Students in the experimental group consistently outperformed those in the control group across all learning domains. Specifically, the experimental group showed a significant increase in self-evaluation of ultrasound skills, indicating that interactive learning methods, such as gamification and multimedia resources, can significantly enhance student engagement and understanding in skill-based education, like ultrasound imaging.
- Survey data reveals a positive reception from students regarding the use of Instagram links as an educational tool. The mean score of 4.42 for the usefulness of Instagram, 4.21 for the relevance of social media in radiology education, and 4.26 for the effectiveness of the Kahoot evaluation system shows that students favor interactive, social media-integrated learning. This is consistent with existing research indicating that platforms like Instagram improve visualization, interaction, and memory retention, especially in challenging subjects such as radiology, histology, and hematology.
- While the quasi-experimental design provides valuable insights, its results are not easily generalizable. Longitudinal studies are needed to assess long-term retention of knowledge and its impact on clinical performance. Future research should also explore how different social media platforms support medical education, beyond Instagram, to understand the broader potential of these tools in teaching.
- This study shows that Generation Z students are particularly open to social media-supported educational initiatives. It is important to examine whether digital platforms foster interactive learning or simply create surface-level engagement. To maximize learning outcomes, educators must strike a balance between evidence-based approaches and creative teaching strategies that effectively integrate these technologies.
- This study adds to the growing body of research supporting the use of digital technologies in medical education. Instagram-based gamified approaches not only improve knowledge retention but also increase students' confidence in their interpretative skills, particularly in areas like breast ultrasound imaging. Although the full potential of social media in education is still being explored, it is clear that these platforms can be a valuable complement to traditional teaching methods, enhancing the learning experience and fostering greater engagement among students.

**Supplementary material:** Kahoot® online learning chapter. https://kahoot.it/challenge/09567141?challenge-id=7911150f-3adc-4069-a4a4-6322342383f2_1741732257667

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