

Development of an Artificial Abscess Model: Its Functional Fidelity for Teaching Nursing Students

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Date Received: 26 October 2025 Revised: 24 February 2026 Accepted: 1 March 2026

Paper Type: Original Research

Abstract

Aim/Purpose: This study aimed to design, develop, and evaluate an artificial abscess model for nursing education. The objectives were to create a model that provides functional realism, measures satisfaction, and improves student competency in performing incision and drainage (I&D). It was hypothesized that students trained with the developed model would demonstrate a high level of satisfaction and improved clinical competency.

Introduction/Background: Skin abscesses are frequently encountered in clinical practice, with I&D serving as the standard treatment in both emergency departments and outpatient settings. I&D is new for nursing students. Because patient safety is paramount and precision when making small incisions is required, students must first undergo extensive practice with part-task trainer models (PTTs) in laboratory settings before practicing with real patients. PTTs are simplified simulation models designed to teach specific procedural skills by focusing on the essential components of a task rather than replicating the entire patient scenario. However, existing artificial abscess models are costly, single-use, and insufficiently realistic in skin texture and pus discharge, thereby limiting training effectiveness when resources are limited. These gaps highlight the need for an affordable, reusable, and clinically realistic simulation model to support safe skills acquisition before patient contact. To address these challenges, the researchers sought to develop an artificial abscess model that would provide the feeling of real skin, allow injections for local anesthesia, incision, pus drainage, and gauze packing for wound dressing—all at an affordable price. Students would benefit from repeated use of the model both in laboratories and in their free time to strengthen psychomotor learning and clinical confidence. This study bridges the gap between theoretical learning and safe clinical practice.

Methodology: Classroom action research was employed using 59 third-year nursing students as the sample. Participants were assigned to three groups based on grade point average (GPA) to ensure comparable baseline academic performance. The model was developed in two stages: (a) development of an artificial abscess model, and (b) trial and evaluation of the effectiveness of the artificial abscess model. Data was collected by using a satisfaction questionnaire (Cronbach's $\alpha = .956$) and an I&D competency checklist (inter-rater reliability = .869). Statistical analysis included descriptive statistics and one-sample *t*-tests that were greater than 3.51 out of 5.00 for satisfaction, and greater than 60% for I&D competency performance.

Findings: The first model prototype, containing 12 pustules, received mean scores below 3.51 for pustule spacing ($\bar{x} = 3.00$) and skin realism for anesthetic injection ($\bar{x} = 3.33$). Participants' feedback consistently highlighted that the pustules were too closely positioned, causing difficulties in anesthetic administration and excessive stiffness and stickiness of the artificial skin.

The second version of the artificial abscess model was redesigned with eight pustules and a softer skin texture to facilitate local anesthesia administration. Evaluation scores demonstrated substantial improvements across multiple aspects, including scores of spacings between pustules from 3.00 to 4.59, realism of skin for anesthetic injections from 3.33 to 4.06, number of pustules from 3.67 to 4.76, and material realism from 3.67 to 4.53. Participants reported high satisfaction, increased confidence,

and improved competence in performing I&D procedures, while recommending further refinements in skin softness, flexibility, and pustule spacing to better replicate human conditions.

The last version of the artificial abscess model featured a tan-colored surface with a sponge core between two silicone layers, and was odor-free, reusable, and suitable for local anesthesia administration. The artificial abscess model included six pustules and an improved formula that reduced stickiness and enhanced skin softness, leading to high participant satisfaction across all aspects ($\bar{x} = 4.78$). However, skin realism for anesthetic injections remained the lowest-rated item ($\bar{x} = 4.48$). Competency outcomes were strong, with a mean score of 77.37% ($SD = 7.62$), significantly greater than 60%. The results indicated that iterative refinement of the model substantially enhanced students' psychomotor performance, confidence, and readiness for safe clinical practice.

Contribution/Impact on Society: The artificial abscess provides an effective and efficient abscess model for practical skills in nursing education, especially for institutions with limited resources. By allowing repeated practice procedures without risk to patients, the model enhances skill acquisition, boosts confidence, and contributes to safer patient care. It demonstrates how low-cost, reusable simulation models can strengthen nursing curricula.

Recommendations: It is recommended that nursing faculties integrate the artificial abscess model into simulation training as part of case scenarios. Similar models should be developed for other essential procedures to broaden the scope of hands-on training.

Research Limitations: The study was conducted in a single institution with a relatively small sample size, which may limit generalizability. Some aspects, such as skin's realism for anesthetic injection, may require further refinement. Long-term transfer of skills into clinical practice was not assessed.

Future Research: Future studies should explore multi-institutional testing, evaluate skill retention in real clinical environments, and compare the artificial abscess model with other simulation modalities such as Virtual Reality or hybrid models. Expanding evaluation criteria with standardized rubrics would also strengthen assessment reliability.

Keywords: *Abscess, incision and drainage, innovation, nursing education*

Introduction

The development of innovation is one of the key policies of the National Education Plan 2017–2036 (Office of Education Council, Ministry of Education, 2017). This plan aims to equip students with skills for the 21st century, particularly analytical thinking skills, research skills, and innovation development skills, especially in the field of public health. Consequently, each faculty needs to develop innovations to train students in various procedural skills. In nursing education, some examples are simulated wounds to practice wound dressing skills (Poko et al., 2019), the “DeeTorJai” Model for chest compression training (Henkaew et al., 2018), or a suturing wound model (Eiamla-or et al., 2021). These innovations aim to develop professional practice skills for nursing students, which are one of four skills specified in undergraduate nursing competency standards.

The management of nursing education is predominantly comprised of two aspects: theoretical teaching and practical training. Practical training is often conducted in conjunction with or following the completion of theoretical study. Before embarking on practical training in a hospital, students must first gain experience in laboratory settings, especially in surgical procedures. Basic surgical skills practiced on models have been widely used in surgical education to minimize errors and ensure patient safety. Practical nursing skills introduce both technical and interactional skills through simulation. Using PTTs, students can safely practice repeatedly, develop accuracy, communication, and confidence, and receive feedback to support safe future practice (Hilleren et al., 2022).

Most nursing practice errors arise from insufficient repetition, resulting in inadequate confidence and heightened anxiety. Practice in the nursing laboratory plays a crucial role in nursing education, particularly in developing psychomotor competencies. Nursing skills requiring fine motor control, precision, logical use of equipment, and patient passivity, such as peripheral vein cannulation,

dressing, minor surgical procedures, etc. (Hilleren et al., 2022). Therefore, strategies for managing practical training in nursing laboratories must be implemented to prepare students for diverse real-world scenarios. These strategies may include procedure demonstrations and re-demonstrations, along with problem-solving by scenario in a simulation lab. Practice may involve mannequins representing either full-body or specific organ systems, depending on the procedural requirements, such as bed baths using full-body mannequins, basic cardiac life support using half-body mannequins, or suturing wounds using only part-task equipment. Fourth-year students, particularly those undertaking primary medical subjects, require intensive practice under the supervision of experienced nurses in emergency rooms, where they encounter a high volume of emergency patients requiring various procedures. Hence, students must practice procedures extensively in laboratories beforehand to become proficient. For the reasons stated above, practical training in nursing laboratories is the core of nursing education; thus, laboratory equipment should closely resemble real-life counterparts, and close guidance from instructors should be provided to develop nursing skills accurately and confidently. This ensures students' confidence before they embark on real hospital placements.

Skin abscesses are frequently encountered in clinical practice, with incision and drainage (I&D) serving as a standard treatment in both emergency departments and outpatient settings. In Thailand, nurses are permitted to perform I&D for small abscesses; therefore, nursing students must receive adequate laboratory-based practice before clinical placement. However, the management of small abscesses through I&D remains relatively novel for nursing students. Mastery of small-scale incision techniques is crucial, as it not only enhances clinical competence, but also requires heightened caution to ensure patient safety during real-world practice. Therefore, before students can practice on real patients in the emergency room or outpatient settings, they should undergo extensive training with simulation models to gain confidence beforehand, ensuring good outcomes and patient safety.

At the Mission Faculty of Nursing, students are taught incision and drainage (I&D) as part of primary medical subjects, and course evaluations are conducted at the completion of the subject. In the past, instructors created artificial abscess models using sponges. However, satisfaction was relatively low regarding the realism of the training equipment, particularly the artificial abscess model. Two key concerns raised were: (a) the sponges tore easily when packing gauze drains, and (b) the models lacked realistic pus discharge, making it difficult for students to visualize the procedure effectively. Additionally, imported simulation models were expensive, single-use, and uneconomical as they could not be reused after incision. This limited students' practice opportunities, hindering their proficiency before working with real patients and requiring them to share models.

To address these challenges, the researchers developed synthetic simulation pads to enhance incision practice for nursing students. These innovative models were designed to closely replicate the texture and characteristics of real tissue and include simulated pus that closely resembles real clinical drainage. This enables students to analyze potential clinical implications and make informed decisions during procedures, thereby providing a highly realistic and effective training experience. Additionally, their cost-effectiveness lies in their reusability, offering a practical alternative to expensive, single-use commercial models. This development not only reduces financial strain on institutional budgets but also allows students to take the models home for extended practice, thereby fostering improved skill acquisition and competency.

Given these stated limitations, the research goal was to develop and produce an artificial abscess model for nursing students. The limitations reported in both prior studies and institutional practice suggested that existing simulation models have not fully met the needs of nursing education in terms of procedural realism, reusability, and affordability for I&D training. This model was developed to provide a similar feeling to real skin. The skin is made from a thin silicone layer with texture that mimics real skin and allows insertion of artificial abscesses. Students can practice injecting anesthetics into the skin, making incisions, draining the abscess, packing the wound cavity with gauze, and applying a dressing to the model.

Packing gauze drains is a very important procedure. Every year, students have lots of questions, such as how much gauze should be inserted to adequately fill a wound cavity, or how to pack the

gauze with minimal pain. These various things depend on practice. Few previously reported training models integrate all these procedural components within a single low-cost, reusable platform specifically designed for nursing students. This model can be packaged in a portable box that nursing students can practice with by themselves multiple times, anywhere, until they gain the required confidence before entering a real clinical setting. Moreover, students can use this model to explain wound-care procedures to patients upon discharge.

Benefits of Part-Task Trainer Models

The artificial abscess model was developed based on the concept of Part-Task Trainers (PTTs), which are simplified simulation models designed to teach and introduce specific procedural skills. (Gent & Kainth, 2022). PTTs emphasize functional fidelity, focusing on replicating the essential aspects of a procedure rather than simulating the entire patient scenario. This allows learners to repeatedly practice specific skills, such as nail removal or incision and drainage (I&D). These nursing procedures require prior practice to develop skills before being performed with real patients. (Thyagarajan et al., 2024; Berger-Estilita et al., 2022). Practicing in the lab enables nursing students to learn from mistakes and receive constructive feedback from instructors without any risk to real patients. By practicing these procedures, PTTs provide structured practice opportunities that reduce novice errors and enhance preparedness for real patient care. Furthermore, PTTs improve patient safety by ensuring that learners reach a sufficient level of competence in low-risk environments before applying these skills in clinical practice (Berger-Estilita et al., 2022; Gent & Kainth, 2022). In this way, the artificial abscess model not only provides an effective educational tool for nursing students to improve their I&D skills, but it also fulfills the broader goal of nursing education: fostering learner development while safeguarding patient outcomes.

Research Objectives

1. To design and develop an artificial abscess model tailored for nursing students.
2. To conduct trials and assess the usability of the artificial abscess model.
3. To evaluate the effectiveness of the artificial abscess model.

Research Questions

1. What is the level of nursing students' satisfaction with the artificial abscess model?
2. What is the level of nursing students' competency in using the artificial abscess model to perform I&D procedures?

Hypotheses

1. The mean satisfaction score of nursing students with the artificial abscess model is greater than 3.51 (out of 5.00).
2. Nursing students' competency in performing incision and drainage procedures using the artificial abscess model is greater than 60%.

Definitions

1. The effectiveness of the artificial abscess model refers to two aspects:

Satisfaction: Students' perception of the model's realism, ease of use, suitability for anesthesia administration, material properties, and application of theory to practice.

Competency: The ability of students to perform the I&D procedure correctly and safely using the model, as assessed by the instructor based on a checklist.

2. Nursing students' satisfaction refers to their level of agreement regarding various aspects of the artificial abscess model (e.g., realism, usability, or practicality), measured using a 5-point Likert scale.

3. Nursing students' competency refers to their ability to perform the incision and drainage procedure in a lab setting, assessed using an I&D competency evaluation form.

4. The artificial abscess model refers to a model developed by researchers to enable students to practice incision and drainage before performing the procedure on real patients.

5. Nursing students refers to 3rd year nursing students from the Mission Faculty of Nursing who have already studied incision and drainage before practicing it.

Research Design and Methodology

Design

This study employs classroom action research by using a research and development design to create an artificial abscess model aimed at enhancing I&D skills among nursing students.

Population and Sample

1. The population consists of 59 junior nursing students.
2. The sample size for this research was all junior students who wanted to participate in this study, but not less than 30 participants, based on Burn & Grove's recommendation (Gray et al., 2017).

Research Method and Instrument

This research was conducted in two stages.

Stage 1: Development of an artificial abscess model.

Stage 2: Trial and evaluate the effectiveness of the artificial abscess model.

Stage 1: Development of an Artificial Abscess Model. This stage was guided by a literature review and expert consultation, and the procedures were developed by the study's authors. This stage consisted of six steps.

Step 1: Analysis of problems caused by traditional equipment used in the past.

Data were collected from course evaluations of fourth-year nursing students who had completed the primary medical care course in the 2024 academic year. The findings revealed that the artificial abscess model used for training was constructed from sponge material, which did not adequately resemble real skin in either color or texture. The model was easily torn, difficult to incise when filled with pus, and only available in limited numbers. Subsequently, students often scored poorly on pre-clinical examinations and were required to retake the procedure. Moreover, the lack of realistic tactile feedback undermined students' confidence when performing abscess incisions on actual patients in real settings. As a result, patients' confidence in the students was also reduced, and some refused to allow students to perform abscess drainage.

Figure 1 *Traditional Artificial Abscess Model*



Step 2: Anatomical study of the skin layer to create the most realistic artificial abscess model.

Step 3: Preparation of equipment needed to produce the artificial abscess model, including the following materials: silicone, sponges, skin color (yellow and tan), flour, plastic boxes, incision sets, and others such as syringes, needles, a weight scale, glass, wood, etc.

Step 4: Production of the artificial abscess model. A sponge was used to represent the muscle structure. Silicone was applied to form the outer skin layer: the first layer was yellow, and the second layer was tan to enhance the realism of the skin. An artificial abscess unit was embedded to simulate an abscess cavity. A plastic box served as the framework to hold the model in place.

Step 5: Production of the artificial pus: flour was mixed with water at a 1:8 ratio and stirred. Yellow coloring was added to achieve a pus-like appearance. The mixture was heated until the flour was cooked and thickened. After cooling, the mixture was injected into the artificial abscess model.

Step 6: The artificial abscess model was given to three experts: two surgeons and one nurse working in the emergency department for feedback.

Step 7: The model was improved in response to comments from the three experts; three rounds of this improvement process were conducted.

Stage 2: Trial and Evaluation of the Artificial Abscess Model. This stage consisted of 2 phases.

Phase 1: Trial and evaluation; this stage consisted of 3 steps.

Participants were recruited using purposive sampling to ensure representation across academic performance levels. Academic performance was categorized using a cumulative grade point average (CGPA) on a 4-point scale. CGPA categories were defined as high (≥ 3.25), moderate (2.75–3.24), and low (< 2.75).

Step 1: The first trial and evaluation process began with testing the model on three individual students. One student was selected from each CGPA range: ≥ 3.25 , 2.75–3.24, and < 2.75 ; this allowed initial usability testing and the identification of major design flaws before proceeding to group trials. This approach aimed to evaluate student satisfaction with the artificial abscess model and furnish data to develop the secondary model.

Step 2: The second trial and evaluation involved testing the model with three small groups, each consisting of five students. The first group included students with a CGPA ≥ 3.25 , the second group had students with a CGPA between 2.75 and 3.24, and the third group comprised students with a CGPA < 2.75 . This process was aimed at evaluating student satisfaction with the secondary version of the artificial abscess model and to inform refinement of the third model prototype. Small-group trials were conducted to obtain diverse feedback while maintaining manageable group sizes for observation and iterative model refinement.

Step 3: Field testing was conducted to evaluate the effectiveness of the final artificial abscess model. The field test involved the full cohort of 59 third-year nursing students and was designed to evaluate the educational effectiveness of the final model under typical laboratory teaching conditions.

Phase 2: Developing a questionnaire. This phase consisted of three steps.

Step 1: Develop two instruments.

1. The satisfaction questionnaire; this questionnaire was adapted from an instrument developed by Eiamla-or et al., (2021).

2. The I&D competency evaluation form was developed based on knowledge derived from three primary care textbooks: Tha-dee and Turnrat (2018), K. Phookjit (2019), and C. Phookjit (2021). These sources provided the fundamentals of local anesthesia, abscess incision and drainage, and minor operative techniques, which were adapted to create the evaluation criteria.

Step 2: Validity testing: the satisfaction questionnaire was evaluated using the Index of Item-Objective Congruence, whereas the competency assessment was validated using the Content Validity Index. Both instruments obtained a score of 1.00 according to the ratings of three experts, who were two surgeons and one nursing instructor.

Step 3: Reliability testing: The reliability of the questionnaire was assessed among thirty senior students who had previously completed the primary medical care course in the 2024 academic year.

1. The satisfaction questionnaire demonstrated excellent internal consistency, with a Cronbach's alpha coefficient of .956.

2. The I&D competency evaluation showed high inter-rater reliability (a coefficient of .869).

Protecting the Rights of Participants

Ethical approval of the study was granted by the Institutional Review Board of Asia-Pacific International University per action RRDC 2024-132. All participants were informed of the study's

objectives, procedures, and their rights to decline or withdraw at any time without any consequences. Written informed consent was obtained from all participants before data collection. The researchers clearly communicated that participation in the study was entirely voluntary. Students were assured that their decision to participate or not participate would not impact on their academic evaluation or relationship with the instructor. The participants demonstrated their willingness to engage in the study without any signs of coercion or discomfort.

Data Analysis

After completing data collection:

1. Descriptive statistics were used to analyze general data.
2. A one-sample *t*-test was utilized to evaluate satisfaction with the artificial abscess model, comparing the standard score, which was hypothesized to be greater than 3.51 out of 5.00.
3. A one-sample *t*-test was applied to evaluate whether the nursing students' competency in using the artificial abscess model was higher than 60%.

Results

Among the 59 participants, the majority were female (85.7%), with a mean age of 21.88 years (*SD* = 1.95). The first version of the artificial abscess model was developed with 12 pustules. Following trials and evaluations by the participants, the model received mean scores below 3.51 in two aspects: the spacing between pustules ($\bar{x}$ = 3.00 out of 5.00) and the realism of the skin for anesthetic injection ($\bar{x}$ = 3.33 out of 5.00). Scores between 3.51 and 4.00 were reported for the number of pustules ($\bar{x}$ = 3.67), the realism of material properties ($\bar{x}$ = 3.67), and the ease of setup for practicing abscess incision procedures ($\bar{x}$ = 3.67) (Table 1).

The feedback from participants was consistent. Many noted that the pustules were positioned so closely together that they appeared to be connected. During the practice, a sterile drape was applied to cover one pustule while another was exposed for treatment. However, because of the dense arrangement, local anesthetic administration was a challenge, as the injected solution might inadvertently diffuse into adjacent pustules. Both experts and students also reported that the artificial skin was excessively stiff and sticky, particularly during needle insertion and withdrawal, which hindered needle manipulation and direction adjustment. Expert feedback was used solely during the prototype development phase and was not included in the quantitative analysis of results. The lack of elasticity in the material was also regarded as a limitation, and several participants suggested that improved softness and flexibility would better replicate human skin. Based on this feedback, a second version of the model was subsequently developed.

The artificial abscess model's second version was redesigned with eight pustules and a modified formula with a softer skin texture, thereby facilitating the administration of local anesthesia. These modifications successfully addressed issues identified in the first model. Overall, participants expressed a high level of satisfaction and noted that it provided a realistic and engaging experience in performing I&D procedures. Most participants had not previously performed I&D procedures on real patients; therefore, their evaluations of realism reflected perceptions based primarily on simulation-based training. Evaluation scores demonstrated notable improvements across several aspects: Spacing between pustules increased from 3.00 to 4.59 (out of 5.00), realism of the skin for anesthetic injections from 3.33 to 4.06, number of pustules from 3.67 to 4.76, realism of material properties from 3.67 to 4.53, and easing of setup for practicing I&D from 3.67 to 4.76 (Table 1).

Participants also reported that the model enhanced their theoretical understanding and increased confidence in performing the procedure. These perceptions were supported by high scores in the questionnaire domain "Application of theory into practice," which included items related to confidence before real clinical exposure and perceived effectiveness for I&D training (Table 1). While the stiffness and stickiness of the artificial skin were generally acceptable, occasionally challenges were encountered during needle insertion and withdrawal. Although the skin exhibited adequate elasticity, further improvements in softness and flexibility were recommended to more closely

replicate human skin. Participants also suggested that increasing the spacing between pustules would provide more room for local anesthetic injections. Despite these limitations, the model was considered highly beneficial for hands-on practice, enabling students to apply theoretical knowledge in a realistic learning environment and thereby improve competence and clinical readiness.

The final version of the artificial abscess model featured a tan-colored surface with a sponge core enclosed by two layers of silicone. It was odor-free, reusable, and allowed for the administration of local anesthesia. This version was further refined to include six pustules and an adjusted formula that reduced stickiness and enhanced the softness of the skin texture. A field test was conducted to evaluate both the model's effectiveness and student performance during its use. Participants reported high levels of satisfaction across all aspects; however, the realism of the skin for anesthetic injections remained the lowest-rated item, with a mean score of 4.48 out of 5.00 (Table 1).

Figure 2 *Artificial Abscess Model: 3 Versions*

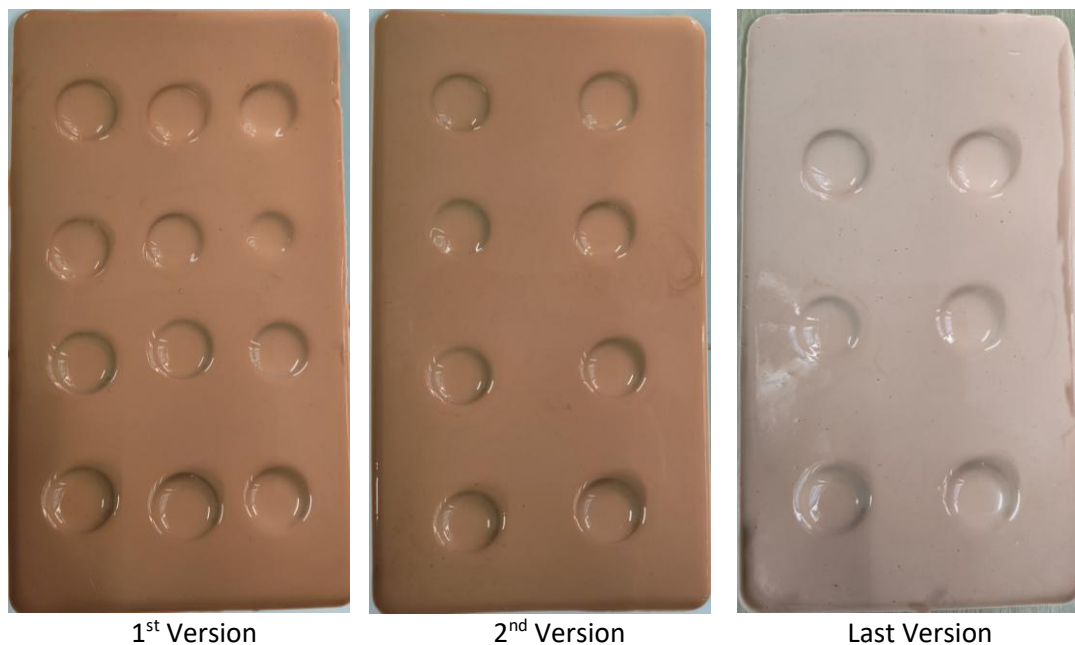


Figure 3 shows the progressive refinement of simulated pus appearance from Version 1 to Version 3 of the artificial abscess model to enhance visual realism for incision and drainage training.

Figure 3 *Artificial Abscess: 3 Versions*

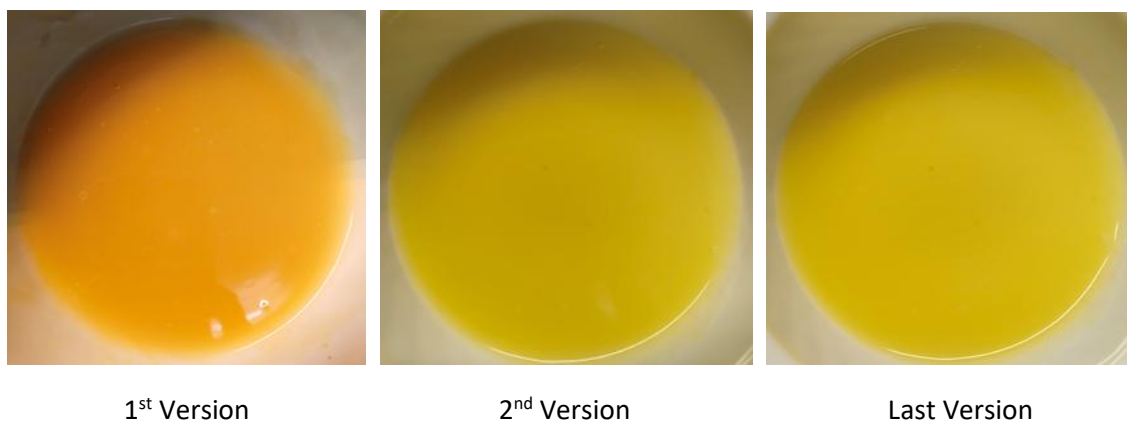


Figure 4 *Equipment for Incision and Drainage*



Figure 5 Incision and Drainage Practice with the Latest Artificial Abscess Model



The satisfaction questionnaire assessed six domains: a) realism of the artificial abscess model, b) practice of local anesthesia injection, c) appropriateness of abscess pustules, d) characteristics of the materials used, e) application of theory into practice, and f) overall satisfaction (Table 1).

Table 1 Participants' Satisfaction Levels with Quality of Artificial Abscess Model 3 Versions (n = 59)

Items	First Model		Second Model		Third Model	
	Mean	SD	Mean	SD	Mean	SD
1. Realism of the artificial abscess model						
1.1 The model closely resembles real clinical conditions of abscess						
– Skin texture	4.00	1.00	4.29	.85	4.51	.62
– Shape	4.00	1.00	4.47	.62	4.80	.40
– Pus characteristics	4.33	1.15	4.94	.24	4.82	.43
Average Scores	4.11	.93	4.57	.67	4.71	.51
2. Practice of local anesthesia injection using the artificial abscess model						
2.1 Convenience of administering local anesthesia	4.33	1.15	4.29	.85	4.55	.64
2.2 Realistic skin for anesthetic injection	3.33	.58	4.06	.97	4.48	.69
Average Scores	3.83	.98	4.18	.90	4.52	.66
3. Appropriateness of abscess pustules on the artificial abscess model						
3.1 Number of abscess pustules	3.67	.58	4.76	.44	4.82	.43
3.2 Space between each abscess pustule	3.00	1.00	4.59	.51	4.82	.43
3.3 Depth of abscess pustules	4.00	1.00	4.71	.47	4.82	.43
3.4 Size of abscess pustules	4.00	1.00	4.82	.39	4.83	.45
3.5 Amount of pus contained within each abscess	4.33	1.15	4.82	.39	4.83	.52
Average Scores	3.80	.94	4.74	.44	4.82	.45
4. Characteristics of the materials used in the artificial abscess model						
4.1 Realistic material	3.67	.58	4.53	.51	4.62	.58
4.2 Perceived safety of materials used	4.33	1.15	4.82	.39	4.92	.27
4.3 Durability for repeated training abscess packing	4.33	1.15	4.82	.39	4.75	.47
4.4 Flexibility of artificial abscess model	4.33	1.15	4.65	.49	4.75	.53
4.5 Ease of set up for practicing abscess incision procedures	3.67	1.15	4.76	.44	4.78	.45
4.6 Portability and ease of storage	4.33	1.15	4.94	.24	4.86	.39
4.7 Cost savings for practical training	4.00	1.00	4.94	.24	4.86	.39
Average Scores	4.10	.94	4.78	.41	4.79	.46
5. Application of theory into practice using the artificial abscess model						
5.1 Facilitation of the application of theoretical knowledge to practice	4.33	1.15	4.82	.39	4.88	.45
5.2 Enhancement of understanding for incision and drainage (I&D) procedure	4.33	1.15	4.88	.33	4.91	.34
5.3 Meeting training objectives prior to performing actual I&D	4.33	1.15	4.88	.33	4.89	.36
5.4 Increasing learners' confidence before performing I&D in real situations	4.33	1.15	4.82	.39	4.88	.41
5.5 Effectiveness for practical I&D training	4.33	1.15	4.82	.39	4.88	.38
Average Scores	4.33	.98	4.85	.36	4.89	.39
6. Overall satisfaction using the artificial abscess model in I&D training	4.00	1.73	4.82	.39	4.83	.42

Hypothesis 1: The mean satisfaction score of nursing students with the artificial abscess model is greater than 3.51 (out of 5.00).

The mean satisfaction score of the artificial abscess model ($M = 4.78$, $SD = .33$) was significantly higher than 3.51 ($p < .001$); please see Table 2 below.

Table 2 Comparison of Satisfaction Scores of Artificial Abscess Model (n = 59)

Topic	Mean	SD	One-Sample t- Value	p Value
Satisfaction Score	4.78	.33	31.216	< .001

Hypothesis 2: Nursing students' competency in performing incision and drainage procedures using the artificial abscess model is greater than 60%.

The mean competency score of nursing students in performing I&D procedures using the artificial abscess model ($M = 77.37$, $SD = 7.62$) was significantly higher than the value of 60% ($p < .001$); please see Table 3 below.

Table 3 *Nursing Students' Competency Scores in Performing I&D Using Artificial Abscess Model (n = 59)*

Topic	Mean	SD	One-Sample t- Value	p Value
Nursing students' competency scores	77.37	7.62	17.51	< .001

Discussion

The model underwent several modifications to enhance its elasticity, spacing of pustules, and suitability for anesthesia injection. Student evaluations indicated that the final version was rated significantly higher in realism compared to earlier versions, especially in terms of tissue flexibility and the ability to perform I&D. These judgments corresponded to improvements in the measured domains reported in Table 1, particularly skin texture, ease of anesthetic injection, realism, pustule spacing, and material characteristics.

This outcome reflected the iterative design principle commonly highlighted in simulation literature: Models must be tested, refined, and validated with learner feedback to achieve functional fidelity. Keller et al. (2022) demonstrated that low-cost peritonsillar abscess models became more effective after adjustments in material composition, thereby directly influencing realism and educational values. This result was similar to that of Watanakit et al. (2024), who developed and evaluated a chest tube insertion training model. The model achieved excellent quality in both functionality and aesthetics and was deemed suitable for teaching and learning. The improvements observed in this study confirmed that fidelity is not merely about external appearance but about functional realism, and that the model needed to mimic incision resistance, anesthetic injection, and drainage in a way that supports psychomotor learning (Berger-Estilita et al., 2022). By achieving this, the artificial abscess model addressed a critical gap in nursing education where commercially available models are often too costly or lack realism for repeated training.

Hypothesis 1: The mean satisfaction score of the artificial abscess model ($M = 4.78$, $SD = .33$) was significantly higher than 3.51 ($p < .001$) (Table 2). Findings demonstrated consistently high satisfaction across all dimensions, including usability, realism, and contribution to learning, with mean scores surpassing the "very good" threshold. Students reported that the model not only enhanced engagement, but it also reduced anxiety when approaching invasive procedures. These perceptions aligned with the questionnaire domains of application of theory into practice and overall satisfaction, which showed high mean scores in the final model (Table 1).

These results were consistent with Adams et al. (2018), who examined the use of abscess models for teaching incision and drainage (I&D) procedures among physicians and nurse practitioners. The study showed that both types of models significantly improved learners' confidence, particularly among novices. These findings support the effectiveness of abscess models as procedural training tools in a safe learning environment before working with real patients. Similarly, Ladowski et al. (2023) developed a novel superficial abscess model that was reproducible to support trainee education. The results received positive feedback from the learners, with medical students and residents reporting that the model provided realistic and valuable experience for practicing aspiration and I&D procedures. In addition, nursing students in this study stated that the abscess model helped bridge the gap between theory and practice.

Done et al. (2020) developed a simple and inexpensive subcutaneous abscess model that provided realistic tactile feedback, ultrasound images, and tissue behavior during incision and drainage, which helped improve students' knowledge and confidence in performing this procedure. Pongcharoen et al. (2021) developed the "SNC Suction Model". This model demonstrated similar benefits, improving both student satisfaction and skill performance.

All these findings reinforce the conclusion that artificial abscess models, when designed to be realistic and user-friendly, can yield high satisfaction levels, promote confidence, and serve as effective educational tools to enhance training and better prepare students for real-world clinical situations. Because most participants had limited prior experience performing I&D on real patients, their perceptions of realism and confidence likely reflected learning gains achieved through simulation-based training rather than extensive clinical exposure.

Hypothesis 2: As shown in Table 3, the results demonstrated that the mean competency score of nursing students in performing I&D procedures using the artificial abscess model ($M = 77.37$, $SD = 7.62$) were significantly higher than the reference value of 60% ($p < .001$). This finding confirmed that the abscess model functioned effectively as a PTT, allowing the students to develop procedural skills in a safe and controlled environment. By focusing practice on a specific clinical task, the model provided opportunities for repetition, feedback, and skill refinement, which were essential for competency development.

These findings were similar with those of Thyagarajan et al. (2024), who developed a cost-effective model and found significant improvements in interns' performance across preparation, incision, drainage, and post-procedure care. The results showed that the model was useful and could support I&D skills in students as effectively as in surgical trainees. Like the research by Chambers et al. (2024), this study developed a low-cost, reusable method for abscess incision, drainage, and foreign body removal. The model provided students with realistic ultrasound imaging and hands-on practice, significantly improving their knowledge and self-reported confidence across all assessed skills.

These results also support the work of MacLean et al. (2024), who used high-fidelity wound care simulations with moulage patients to enhance students' clinical competency, situational awareness, and reflective practice, proving that simulation is useful for linking classroom knowledge to real-life practice. Similarly, Ladowski et al. (2023) developed a superficial abscess model and reported positive feedback from trainees, who highlighted its realism and educational value for practicing aspiration and I&D procedures. In addition, de Lima et al. (2025) introduced a pericardiocentesis simulation model that served as a dedicated PTT for a high-risk procedure. Their results demonstrated that repeated practice with the model significantly enhanced learners' psychomotor skills and preparedness for clinical application.

All these findings emphasized that PTTs, whether for I&D, wound care, or pericardiocentesis, were highly effective in improving learners' competency. According to a study by Maneewong et al. (2023), creating classroom environments that resemble clinical practice and simulating real-life situations can significantly enhance students' learning and support long-term knowledge retention. Thus, the artificial abscess model used in this study extends the evidence base by providing quantitative validation that simulation-based task trainers translate engagement and realism into measurable performance gains, thereby preparing nursing students for more effective real-world clinical practice.

Implications

The artificial abscess model demonstrated strong educational value in nursing curricula. This model allowed repeated practice of incision and drainage without risk to patients, enabling learners to build psychomotor skills safely and effectively. Students reported greater confidence and reduced anxiety when performing the procedure, which indicated that the model not only supports technical learning, but also enhances readiness for clinical practice. Although certain aspects, such as skin realism during anesthetic injection, may still require refinement, the overall outcomes highlight the potential of low-cost, reusable PTTs to improve access and equity in nursing education. Future research may consider including practicing nurses in clinical settings to further explore the model's realism and practical use. Evaluation across multiple institutions could also help broaden the understanding of its applicability. In addition, examining longer-term learning outcomes may provide further insights into the model's educational impact.

Conclusion

The artificial abscess model successfully combines functional realism, high student satisfaction, and measurable gains in competency. As a low-cost and reusable model, it represents a practical solution for strengthening nursing education, particularly in resource-limited settings. This study provides evidence that targeted task-specific simulation supports safe skill development and enhanced learning outcomes, preparing students for more effective clinical practice.

Acknowledgements

The researchers would like to express sincere gratitude to the Mission Faculty of Nursing and Asia-Pacific International University for providing research funding. The valuable input of the three experts in validating the research instruments is gratefully acknowledged, as their recommendations and comments greatly contributed to this study. Appreciation is also extended to the third- and fourth-year nursing students who provided information and participated, as well as to the laboratory staff for their assistance in the development of the model.

Author Contributions

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