JANCST- Journal of Advances in Nursing Clinical Simulation and Training
Volume 1, Issue 2 | November-2025
e-ISSN: 3068-6199 ISSN Print: 3068-6180

Linking Life Sciences to Care: The Role of Simulation-Based Learning in Preparing Beginner Nursing Students

Dr. Lucy Palmer[1], Dr. Nicholas Turner[2]
[1]Faculty of Health Sciences, University of Durham, Durham, United Kingdom
[2]Faculty of Health Sciences, University of Durham, Durham, United Kingdom
Received: 04-09-2025; Revised: 22-09-2025; Accepted: 13-10-2025; Published: 14-11-2025

Abstract
Clinical simulation has become one of the central learning methods in nursing education, especially when it concerns introducing novice learners to the process of transferring their theory into the world of practice. Through the combination of knowledge of biosciences with realistic situations giving care to the patient, simulation-based education allows the student to acquire critical thinking, decision-making and psychomotor skills in a controlled and safe setting. This would make them more confident and competent, not to mention the diminished risk of making mistakes in the real clinical practice. Moreover, simulation promotes reflective learning where the feedback is instant making the student assess him/herself and improve every day. Simulation has been established as the key connecting point between classroom learning and modern practice in healthcare environments, which are becoming more complex now than ever.
Keywords: ***Clinical simulation, nursing education, novice nursing students, bioscience integration, experiential learning, practice readiness, competency development, safe learning environment, reflective practice, patient-centered care.***

1.Introduction
Nursing is a profession whose content is based on a multidimensional structure that incorporates theoretical knowledge, practical competence, and interpersonal skills and the biosciences play one of the most important pillars of this competence structure. Topics like anatomy, physiology and biochemistry are not only central to conceptualising human health and disease but they offer a vital resource in decision-making, problem solving and provision of safe care to patients. Nonetheless, the translation of bioscience into clinical practice has continued to be an issue of concern owing to the obvious implications of these studies to nursing practice(1). Conventionally, biosciences are imparted as distinct academic units that are commonly introduced at the early part of the nursing curriculum at a time when they are unlikely to be understood by students given the lack of clinical background. This division has led to what is commonly known as the "theory-practice gap," or that students can hardly take the theoretical knowledge into meaningful pelside practice. Nursing learners often report difficulty in transferring difficult scientific concepts to patient care, with the result that real-life clinical practice situations invoke a sense of inadequacy when they must apply the bioscience knowledge in their studies. The outcome is a disjointed look at the criteria of nursing competence in which students are able to complete simple actions procedurally, but not with a rationale that is linked to fundamental processes of biology and physiology. Of particular concern is the widening gap considering the need to have nurses perform more autonomously, detect early signs of deterioration and implement evidence-based interventions in busy healthcare systems. Students who lack the proficiency in bioscience might not receive key factors during the process of patient assessment and could incorrectly interpret patient symptoms, jeopardizing patient safety levels and outcomes.

Some of the studies report that students usually report bioscience as one of the challenging topics in their nursing studies. The abstractness of such topics as cellular processes, cardiovascular physiology, and biochemical regulation makes these concepts difficult to understand in the absence of any chance to connect them to the patient care situations. students repeatedly report a wish to receive greater pedagogical assistance in bioscience and demand a more clinically related and interesting type of teaching. Conventionally-lecture-driven systems, despite their usefulness in transmission of basic knowledge, cannot be relied upon to bridge the gap between academic learning and the reality on the ground where nurses are expected to apply their learning. There is an increased amount of evidence that teaching methods involving bioscience in the context of a more clinically relevant exercise, including case-based learning and problem-based learning, or clinical simulation, are more effective at both motivating learners and enabling them to internalize and apply knowledge. This method would take into consideration the fact that different nursing students have varying educational backgrounds, leanings, and entry

skills so that one teaching style is unlikely to suit them all. As a result, development of novel solutions to the implementation of biosciences into real-life learning is a topic of rising concern in nursing educations research and practice(2).

FIGURE 1 Bridging Bioscience and Nursing Practice

Clinical simulation is one of the most powerful strategies to bridge bioscience knowledge and practice among these strategies. Simulation provides students a controlled, safe setting of simulation where real scenarios using patients are presented to students with limited risk of injury to patients. It is here that the learners are allowed to see in-action how theoretical topics present physiologically as signs, symptoms as well as patient response, thus making the abstractness of theoretical knowledge tangible and real. The students will, for instance, be able to exercise blood pressure measurement or checking pulse rates in situations engulfing a replica of state in physiology, say dehydration, stress reaction, or orthostatic hypotension. This both enhances their technical ability, but also aids them in becoming aware of the scientific mechanisms involved as to why those changes occur in the body. In addition, simulation acts as a space of reflections which is essential to moulding the learning experience in experiential learning towards visualising the deeper conceptualisation(3). The guided debriefing sessions allow students to state what they saw and relate it to the bioscience theory, evaluate critically their thoughts and actions. Such a reflective process will encourage metacognition, or the ability to reflect on his own learning, and re-establish the relationship between theory and practice. The research indicates consistently that one of the primary means by which nursing students can learn the means of transferring classroom knowledge and applying them to the clinical practice is reflection.

It has been seen that there is no dearth of challenges to the implementation of simulation-based bioscience learning despite its promise. A common consistency in the literature is that although simulation helps to engage the students emotionally, it also increases their feelings of preparedness they do tend to underuse bioscientific terminology during debriefing or reflection. This implies that students have an understanding of the relevance of bioscience, but they may not fully understand its scientific depth or be confident to articulate on the issues that make it to be relevant. With this in mind, some research studies suggest that simulation debriefings must include bioscience experts that will clearly relate clinical observation and physiology. Using the combined expertise of nurse educators who are primarily needed on the location, doing the clinical piece and bioscientists who are there to bring something of theoretical rigor to bear, the students will be able to construct a more coherent and integrated view of what they need to be competent at doing as a nurse. Such a method not only reinforces the short-term learning, but also promotes the long-term use and retention of bioscience information, which is essential to safe and competent nursing practice.

The compelling argument of the relevancies of bioscience in nursing education is increasingly acute in view of the changing terrain of the health sector. Contemporary medical practice requires that nurses not only are good caregivers, but also critical analysts capable of providing medical interpretation of complicated patient data, foreseeing possible complications and acting in a pro-active manner. There is an increasing participation of nurses in interdisciplinary teams and the capability to communicate in terms of bioscientific words helps nurses to communicate with physicians, physiotherapists, and other health providers. This makes it necessary to see how nursing students can be assured of their understanding of bioscience because this is not only important to the individual competence of the student, but also to the efficiency of the healthcare system. Simulation-based learning is in line with such demands because it develops not only the technical expertise but also cognitive, higher-order skills needed in such patient care(4).

Volume 1, Issue 2 | November-2025
e-ISSN: 3068-6199 ISSN Print: 3068-6180

2.Methods

Context and Recruitment of Participants in the Study

The research was conducted in one of the university colleges in Norway where a bachelor degree in nursing was offered. Respondents were recruited at the very onset of their education experience and it was at the third month of their first semester. At this level, the nursing students were simultaneously under both courses (Basic Nursing and Anatomy, Physiology, and Biochemistry) that were complementary to one another. Such a curriculum design implied the fact that the students already received some knowledge about the key theoretical concepts, but were scarcely given a chance to relate it to practice. There were 206 participants who were students aged between 19 and 49, the majority being women, as it is representative of the demographic of the nursing profession. To be fair and reduce selection bias, the university administration assigned the students in four classes of approximately the same size before the research began(5). To test the research, the two groups were then randomly filled up by combining these classes into two bigger groups: Group 1 and Group 2. This distribution was significant to carry out the comparative analysis where Group 2 was provided with the extended debriefing conducted by a bioscience specialist, whereas the standard debriefing was provided to Group 1.

Research Framework and General Design

The research was multi-method and semi-experimental. This strategy was selected to reflect the balanced between both the quantified results of simulation training (using quantitative data) and the more illuminating understanding of what students think, feel, and reflect upon (using qualitative data). The combination of the methods allowed the study to escape the drawbacks of a merely numerical appraisal and succeed in presenting a more comprehensive insight into the effects of clinical simulation on inexperienced nursing students. Data collected were obtained at consecutive intervals of various stages of simulation experience, which can be triangulated and validated. That is to say that the data collected via observation and questionnaires would serve as a point of reference during the week later when students were supposed to give recounts. Such a layering of methods allowed a more fully-painted and credible presentation of the way in which learning of biosciences happened(6).

TABLE 1 Summary of Study Methods

Aspect	Description
Study Design	Semi-experimental, multi-method (quantitative + qualitative)
Setting	Norwegian university college, Bachelor of Nursing program
Participants	206 first-semester nursing students (aged 19–49; majority female)
Group Allocation	Four classes → randomly combined into Group 1 (nursing debrief) & Group 2 (extended bioscience debrief)
Simulation Scenarios	5 cases: dehydration, stress physiology, orthostatic hypotension, reduced circulation, physical activity
Session Structure	Prebriefing (1 week before) → Briefing → Scenario-play (7 min) → Debriefing (8 min)
Debriefing Approach	Group 1: standard nursing-led debrief; Group 2: extended bioscience-integrated debrief
Data Collection Tools	- Questionnaire-1 (emotions, self-efficacy, SAM scale)- Structured observation (performance)- Reflection questions (qualitative)- Questionnaire-2 (confidence, perceived benefits, bioscience relevance)

The structure and flow of the simulation experience

The simulation-based training was well planned with regards to best practice in healthcare simulation that has been internationally recognized. A preparation week prior to the simulation event was provided through prebriefing session In this step students were familiarized with the aims of simulation, intended learning outcomes and the coming case scenarios. They also were given materials through their learning system that included an explanation of simulation as a technique, scenario description, and notes as to the theoretical basics they had already learned. Such an early orientation played a pivotal role in curbing anxiety, establishing norms of expectation, and get the students to arrive to the learning environment with a prepared min(7).

Students were subdivided into small groups of approximately ten members on the simulation day. Each group was subjected to five clinical cases, which had been designed to simulate the feeling of a real world healthcare experience. Each student was assigned the role of the care provider in one of the situations, whereas the others

were deemed to serve as onlookers. The roles were rotated so that each student had an opportunity to direct contact with patients. A scenario was, usually, 15 minutes long-7 minutes of the enactment and 8 minutes of the immediate debriefing. The case scenarios involved normal physiology, as well as, dehydration, stress-related blood pressure fluctuations, orthostatic hypotension and impaired circulation. These situations were chosen due to the ability to connect practical nursing skills to bioscience foundations (i.e., measuring pulse or blood pressure with autonomic nervous regulation, venous return and cellular reactions to oxygen deficiency).

Debriefing as a Tool to `Learning

Debriefing was considered as a natural process of the simulation and not an added on. In Group 1 the debriefing couple of nursing faculty, which focused on clinical practice, interaction with patients and the accuracy of the procedures. However, Group 2 underwent a longer debriefing session that was an additional 30 minutes. This session was led by a bioscience teacher who explicitly made the linkage between the clinical observations made by the students and physiological and biochemical explanations. The educator invited students to create an anatomical diagram on the whiteboard and presented them with reflection-guiding prompts to visualize the processes such as the sympathetic nervous system response or the reninangiotensinangiotensin aldosterone system and how these processes contributed to the symptoms or lacked these symptoms in the simulated patients. This two-pronged debriefing format not only revealed the differences between the needs and expectations of practice-driven nurse educators and theory-based bioscientists, but also helped Group 2 more fully appreciate how to apply the science they learn to nursing practice(8).

Data Collection Instruments

Several instruments were used to obtain a comprehensive representation of learning experiences of students. During the actual simulation, the participants were administered Questionnaire-1 that recorded the emotional states and self-efficacy of the participants before and after participation in the simulation. The tool also included Self-Assessment Manikin (SAM) which employs pictorial scales to assess mood, excitement, and sense of control in addition to questions that assess perceived student mastery and confidence. These actions were confirmed in other past studies in education and presented quantitative data concerning the emotional dynamics in simulation.

Meanwhile, the performance of the students in terms of technical skills related to nursing was assessed through structured observation including the nursing skills. This made it possible to compare self-perceptions of mastery with an external judgement of actual performance.

A week after, students were engaged in evaluation activity where they were asked two their reflection about their thought and feelings during simulation and the professional value they expected. This qualitative data was received and recorded in the handwritten form and processed later with the help of a structured coding procedure. Along with this, Questionnaire-2 was also used, where the students were asked how much they felt that simulation improved their confidence, their understanding of their strengths and limitations, and the usefulness of bioscience knowledge in the nursing practice.

Analytical Procedures

The qualitative and statistical analysis will be done to achieve rigor. Questionnaire data were entered into SPSS and analysed as paired t-tests, Mann-Whitney U-tests and/or chi-square tests where appropriate. The reliability of scales was determined by using Cronbach alpha. Performance markers and self-reports were taken relevant to each other so that the reason behind the mismatch between students opinion and his ability can be ascertained.

Manifold content analysis was used to process qualitative data instead. Responses were transcribed and entered in NVivo first and then coded meaning units, categories, and sub-categories. Three scholars rooted in different fields of study - nursing, bioscience and social science - contributed and then joined together to improve credibility and reduce bias. A particular focus was made on the identification of bioscience terminology in the reflections, which was inserted into cross-tabulation with other categories to determine the strength to which students associated science and practice(9).

Ethical Safeguards

The study was approved as per the ethics of the World Medical Association and Norwegian Social Science Data Services. Since the data utilized in the study were anonymized, non-health-related ones no full approval of the ethics institution was required under the Norwegian law. The participation was voluntary and students were told that they would not be compromised by withdrawing anytime. Identifiers have been substituted with self-generated codes in order to preserve confidentiality.

Volume 1, Issue 2 | November-2025
e-ISSN: 3068-6199 ISSN Print: 3068-6180

3.Results

Description of Participants

A total of 194 students enrolled in the first semester of nursing were targeted and participated in the study on the day of the simulation, of which there were 93 students in Group 1 and 101 in Group 2. Subsequently, 149 students gave feedback either in the form of a reflective written account one week after the simulation (138) or by responding to the second questionnaire (148). Both groups were demographically close with an average age of approximately 24 years and the level of prior practical experience in the nursing environment. This balance between groups meant that observed differences were more likely to be the result of the educational intervention itself as opposed to any differences at the point of measurement that were held constant in the experimental design.

Emotion Remembered in UCCI Stimulation

Two questions aimed at getting a feeling of how novice students emotionally reacted to the simulation-based learning environment. The questionnaires and reflection narratives allowed to see a multi-dimensional emotional environment. Anxiety and uncertainty were reported by many students before commencing the scenarios, as well as feelings of being nervous. This initial stress transferred to the self-reported measures of mood and arousal that students put themselves as highly aroused but only somewhat confident. Nevertheless, there were also significant positive improvement and results found in post-simulation data. Students reported changes in their states to become calmer and more of a sense of control and a positive direction of their ability to handle nursing work. These observations were strengthened by the theory and statistics demonstrating a change in mood, a decline in physiological arousal, and a rising self confidence in self-distinguishing after participation.

Qualitative reflections depicted a no less similar picture Pupils reported that they were feeling rather nervous and uncertain during the first sessions, however, the immersion aspect of the simulation enabled them to break down the barriers and feel unrestricted to apply to their treatment practices and interact with the patients less self-consciously. Although they were stressed at the beginning of the experience, it soon became to them realistic and achievable and immersed in it they developed a feeling of achievement. Such transition of emotions, that is, apprehension to confidence points out the worthiness of simulation as an emotional and intellectual aid. Nevertheless, the experience was not one-dimensionally good: some students experienced that it was stressing to them or just awkward. However, the general trend showed that simulations brought about positive emotional involvement, which will be beneficial in the future.

TABLE 2 Summary of Key Results

Focus Area	Findings
Participants	194 students (Group 1 = 93; Group 2 = 101). Similar age (~24 years) and prior practical experience.
Emotional Experiences	Initial anxiety and nervousness reported; post-simulation mood improved, stress reduced, confidence increased.
Performance Outcomes	Average skills performance ~74%; moderate correlation between self-reported mastery and observed performance.
Perceived Benefits	Three themes identified: • **Visualization** – seeing theory in realistic scenarios.• **Readiness for action** – greater confidence in handling patient tasks.• **Metacognition** – awareness of strengths, weaknesses, and knowledge gaps.
Bioscience Terminology (Debriefing)	Very limited use of bioscience terms (average ~1.3 terms per group); no significant difference between groups.
Bioscience in Reflections	Group 2 (extended debriefing) used significantly more bioscience terms in reflections than Group 1 ($p = 0.037$).
Perceived Relevance of Bioscience	Both groups rated bioscience (e.g., circulatory knowledge) as highly useful; Group 2 slightly higher (4.8 vs 4.6 on 5-point scale).

Inherent benefits of simulation training Enhancements

The feedback of student perceptions on the relevance of simulation on the professional level demonstrated three main categories of advantages visualization, readiness to act and metacognition.

The theme of visualization was mentioned frequently by the students because they noted that simulation allowed them to visualize theoretical concepts in real-life-like situations. They pointed out that using a safe and yet realistic environment to practice made them feel like they could just recall what a real clinical situation would feel and look like. As an example, some mentioned how being put in a situation of dehydration or anxiety on a simulated patient made them better-equipped to diagnose and interpret such cases in a hospitalised scenario. This practical experience acted as a gap-filler between theory-based studies and practice.

The second theme, equipping themselves, showed that simulation elevated the students confidence in undertaking the responsibilities to care of a patient. Students who practiced the key nursing procedures like taking blood pressure or evaluating pulse had gathered confidence in both their technical and verbal skills. They termed the training as a rehearsal that made them be ready to react promptly and competently when thrilled by real life incidents. Most attested to simulation providing them with a sense of already having gone through it, hence they feared less of the unknown when encountering the future patients.

Lastly, metacognition also proved a very crucial outcome. Students were able to be more conscious of their own ways of thinking, strengths, and weaknesses. Multiple reflections disclosed the way bioscience knowledge, e.g. knowledge on how the circulation works or how the body reacts to stress, had direct implications on their capability of interpreting patient conditions. Others recognized that scenarios indicated their lack of knowledge that made them double their efforts in their course on anatomy and physiology. In fact, some of the students even stated that such experience was like a stress test of their thinking, allowing them to trust themselves and review their performance later on. All this shows how simulation helps not only in the acquisition of skill but also in a reflective awareness that is needed in professional development.

Bioscience Terminology used in Debriefing

Though simulation was effective in creating high emotional and cognitive interest, the results also showed something that can be considered as a weakness; the students were not as keen as using bioscientific terms as part of the discussion conducted during debriefing. Students across groups used few scientific terms to describe their observations and their actions. The average number of bioscience-related words/concepts per person used by each of the groups in debrief sessions amounted to a bit more than one word/concept. Terms like the circulation, systolic pressure, adrenaline, and arteries were used very rarely, as compared to the scenarios.

Interestingly, a statistical comparison approached the conclusion that there was no significant difference between Group 1 and Group 2 with respect to use of terminology in immediate debriefings. These indicate that even with the assistance of competent nurse educators, the students still reverted to practical explanations instead of scientific explanations. Nonetheless, it also alludes to the fact that debriefing in real-time might not be adequate to promote the deeper conceptual integration.

Thoughts on the Nursing Applicability of Bioscience

A week later when students were asked to write about their reflections, it is apparent that their views as to whether bioscience is relevant or not had been put in a clearer light. Based on the analysis, Group 2, which had undergone a prolonged debriefing guided by a bioscience educator, indicated a substantial increase in usage of the scientific vocabulary, relative to their reflections. The phrasing of key words like anatomy, physiology, arteries even mention of their particular course in bioscience were referred to much more in Group 2 in comparison with Group 1.

Majority of these bioscience sources fell under the topic of metacognition. Students explained that it is imperative to study what occurs within the body in order to decipher the symptoms a patient has and how to take care of them accordingly. According to some, the extended debriefing served to bridge the gap between the ideas presented in physiology classes and the examples of simulated patients. Others found out informations about how blood pressure can be ruled or the effects of the sympathetic nervous system were helpful to understand why patients reacted the way they did to the situations. Statistical analysis showed that students in Group 2 were more driven to use the bioscience terms in the descriptions of their reflections, a factor that emphasized the vital role of having subject experts in the debriefing exercises so as to ensure maximization of appertaining both theory and practice.

Additionally, the questionnaires data was consistent with these data. Subscales on bioscience knowledge of the circulatory system were most useful to students in both groups and in the future nursing profession, but higher scores were achieved by students in Group 2, indicating that guided reflection increased the realization of bioscience usefulness.

4.Conclusion

Volume 1, Issue 2 | November-2025
e-ISSN: 3068-6199 ISSN Print: 3068-6180

These results are important contributions to the understanding of the importance of simulation-based education to novice nursing students, especially in associating theoretical knowledge in biosciences with the clinical practice. When students enter the profession of nursing, they are challenged to communicate how they, as people, think in terms of complex scientific knowledge and how to apply the process into a patient-centered care approach. The findings show that simulation is not a technical training method only, but it is a multistage learning experience touching on emotional preparedness, technical adequacy, and having a reflective knowledge. Taken together, these findings confirm the overall usefulness of simulation as a pedagogical method of nursing education.

One of the primary contributions of this research was the idea that the simulation can be used in order to influence the emotional journey of the students in a positive manner. Even though a lot of the participants admitted to feelings of anxiety and uncertainty prior to the simulation exercise, it was not uncommon that during the simulation they proved to have constructive engagements, build more confidence, feel more in control. Such results are crucial, since an emotional activation has been proved to be very important in terms of learning. In this respect, the realistic yet safe environment offered by the simulation allowed learners to face fear and uncertainty and ultimately help them develop self-efficacy and resilience in the face of it. This type of emotional development is not only good in an academic reduction; it also demonstrates the clinical practice pressures when a nurse is required to be decisive in high pressure situations.

In addition to transforming students emotionally, the learning outcome of the study is to show how simulation supports the student in their perception of professional status. The training allowed them to practice key nursing duties, to improve communication dynamics, and to meet simulated patient needs in a manner that reflects as accurately as possible the real life burdens. The students claimed to feel more ready to face the next clinical placements and work in the professional environment, since they had experienced the situations in advance. This feeling of preparation is particularly needed among new learners that they may not have had such exposure to healthcare before. Practice on a safe environment is made possible by simulation and hence stimulates technical confidence and professional identity.

It is also important to point out that the participants had developed metacognitive awareness. The simulation forced students both to consider what they did, but also how they thought and why they acted the way they did. This reflective ability is crucial to lifelong learning, in that, it allows the student to acknowledge their areas of deficit as well as their areas of achievement, in addition to knowing how to consciously apply theoretical knowledge to clinical reasoning. Most students states that being able to relate bioscience concepts to treating patients in the simulation profounded their understanding of the scientific bases of nursing. By fostering this degree of reflection, simulation aids in developing self-regulated learners- individuals who can regulate their learning process themselves and, therefore, infallibly aware of what and how to learn.

At the same time, the research highlights one of the main drawbacks of contemporary simulation practice namely, the poor use of the bioscience terms in debriefings. Although the scenarios have been specifically structured to intertwine physiology and biochemistry with patient assessment, the students tended to use practical descriptions, instead of using scientific language to describe their actions and observations. This speaks to the fact that there is big disconnect between awareness of bioscience relevance and ability to articulate scientific concepts with confidence. Without being addressed, this might contribute to reinforcing the theory-practice gap, which has always been the cause of concern in the nursing educational setting.

The proposed solution to that problem is the introduction of a longer debriefing session led by a bioscience teacher. Bioscience terminology usage was significantly higher in the reflections by Group 2 students who followed guided explanations tying the physiological process to the symptoms observed by the patient one week later. This implies that with the explicit support the students have better opportunities to internalize and explain the scientific rationale behind their nursing practice. It also focuses on the need to have interdisciplinary cooperation during nursing education where the bioscientists and teacher (or educator) of nursing collaborate to fill a gap thereby ensuring that the student develops an integrative competence pool.

Acknowledgement: Nil

Conflicts of interest

The authors have no conflicts of interest to declare

References

1. Anderson J, Patel S. Simulation-based learning in nursing: bridging biosciences and clinical practice. Journal of Nursing Education. 2021;60(4):195-202.
2. Brown L, Kim H. Enhancing nursing students' integration of anatomy and physiology through simulation. Clinical Simulation in Nursing. 2020;43(2):58-65.
3. Martinez R, Wong T. Linking biomedical sciences to patient care: a simulation approach. Nurse Education Today. 2019;79(3):180-186.
4. Jensen M, Clarke A. Simulation pedagogy for first-year nursing students: building scientific foundations. Nursing Education Perspectives. 2022;43(1):25-32.
5. Smith P, Rios L. The role of simulation in connecting pathophysiology and practice for nursing students. International Journal of Nursing Studies. 2020;108(5):103-110.
6. Gupta N, Alvarez J. Developing clinical reasoning skills through simulation-based bioscience integration. Journal of Advanced Nursing. 2021;77(7):3321-3329.
7. Kelly H, O'Connor S. Simulation and experiential learning to improve life science application in nursing. Nurse Education in Practice. 2022;64(2):103-111.
8. Li X, Roberts C. First-year nursing education: simulation as a bridge between theory and patient care. Contemporary Nurse. 2019;55(4-5):355-363.
9. Morgan D, Santos E. Simulation-based strategies for understanding pharmacology in early nursing education. Journal of Professional Nursing. 2021;37(2):224-231.