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The Deficiency-Time Allocation Model: Developing a Formulaic Strategy to Improve Nursing Student Independent Self-Education

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Abstract

To our knowledge, this is the first published, transparent, formulaic time-allocation tool for nursing education exam preparation grounded in utilitarian learning theory. Nursing education has shifted to flipped classroom, asynchronous, and self-directed learning after the COVID-19 pandemic. Nursing educators must meet the increasing demands of these new learning methods by exploring practical ways of improving nursing student education and learning. The Deficiency-Time Allocation (DTA) model has been developed as a formulaic strategy to improve self-directed study guidance. A bioethical utilitarian framework guided the formulation of DTA, grounded in three bodies of research: 1) the relationship between study time and performance, 2) Mastery Learning, and 3) Deliberate Practice. DTA guides a learner on how many hours of studying they should allocate to topic deficiencies based on the hours that learner has available. The conceptual justification of this tool has been reviewed by experts, with mathematical verification and face validity. The next steps are empirical validation, feasibility, and acceptability.

Keywords

NCLEX-RN, Study Planning, Mastery Learning, Deliberate Practice, Test Preparation, Utilitarianism

1. Introduction

Nursing education has undergone substantial structural changes since the COVID-19 pandemic. There is a shift toward non-traditional methods of learning in nursing schools, including flipped classroom, team or case-based learning, asynchro-

nous, and self-directed learning [1]. The nursing education paradigm has also shifted from the pedagogical assumptions of traditional school learning to the more mature andragogical needs of the adult learner [2]. As adult learners, nursing students face limited hours in the day to study effectively for their exams.

Nursing student test performance in the National Council Licensure Examination for Registered Nurses (NCLEX-RN®, which we will simplify to NCLEX) has room for improvement. In 2025, the first-time US test takers' pass rate dropped by 4.5 percentage points (from 91.2% to 86.7%) [3]. All test candidates, including repeat US, first-time international, and repeat international test takers' pass rate fell from 73.3% in 2024 to 69.1% in 2025. The pandemic may have exposed and exacerbated existing weaknesses rather than creating entirely new problems. The US dropout rate for nursing students is roughly 20%, with some attrition rates reported as high as 50% [4]. This incurs the economic cost of training those who dropped out.

Therefore, finding ways to improve nursing education through guided test-taking preparation is an important step to improving student performance and the future of our healthcare system. Nursing students will have an improved understanding of the content covered on their exams. Faculty will have evidence-based insights for their curriculum as the curriculum adapts to the post-COVID learning modalities. Institutions will have informed classroom implementation and retention. In the long run, patients will receive better overall care from nurses who have skillfully passed their licensing exams and met the foundational requirements for success.

Allocating time towards areas of improvement is vitally important for nursing students to improve their exam scores. However, doing so can be difficult under stressful circumstances, especially during dedicated study periods. According to research, learners do not follow act-utilitarian principles of hypothetically maximizing their study time [5]. Further research is needed on utilitarian methods of studying. Additionally, there has not been a consensus on a best practice for an educational strategy for the NCLEX exams [6]. Faculty and nursing student perspectives differ on what drives exam success on the NCLEX [7]. While existing studies have evaluated many of the known factors that play a role in NCLEX success, such as GPA and preadmission testing [8], there is a gap in the literature regarding how one's time management plays a role in successfully passing this standardized test.

Therefore, there is an identifiable gap in existing study-guidance tools for nursing students. The current commercial educational adaptive platforms are black boxes that do not disclose the underlying algorithm or logic [9]. Students in the health professions often cannot reliably identify their own deficits [10]. This need has led to the development of the Deficiency-Time Allocation (DTA) model, a formulaic strategy to improve self-directed study guidance. Such a model was developed with a utilitarian bioethical framework grounded in three existing theoretical constructs. The model has gone through a preliminary expert review at face

validity, with a planned empirical validation and eventual implementation in the post-COVID academic setting.

2. Theoretical Framework

DTA is grounded in a utilitarian ethical framework. Conceptually, utilitarianism posits that one must act in such a way that will maximize one's overall well-being. While utilitarianism is about maximizing aggregate welfare across persons, the rational optimization of one's test score serves as the instrumental means to this aggregate end. In this sense, the nursing student learner must act in such a way that would improve their test scores. This leads to better prepared nurses improving patient care, thereby maximizing aggregate welfare for all. This basic concept extends to the educational realm by finding a methodology that will lead to optimization and the academic success of the test taker. Utilitarianism therefore contributes to DTA by supplying a normative justification for allocating scarce time where marginal benefit is greatest. We hypothesize that this allocation will improve exam readiness. DTA is therefore grounded in three utilitarian bodies of research.

The first utilitarian body of research is the well-studied concept of the relationship between study time and performance. It has been agreed upon by the academic community that the more time one dedicates to studying, the higher one performs [11], although this relationship holds most reliably when study quality is accounted for [12]. This feeds into the basic premise and foundational assumption behind DTA. Allocating more hours to a topic of deficiency will yield better results on that topic.

The second utilitarian body of research is Mastery Learning. According to Mastery Learning, students must achieve a level of mastery in prerequisite knowledge before moving forward to the next topic [13]. This theory focuses on targeted feedback to address learning gaps. Applying Mastery Learning has historically led to an increased number of students scoring well on their exams [14].

The third utilitarian body of research is Deliberate Practice. Deliberate Practice focuses on the student's weaknesses to refine their skills [15]. According to this theory, one must focus on low-scoring areas in order to improve. This is a clear example of a utilitarian implementation. The fundamentals of Deliberate Practice are still being applied to healthcare education in this current decade [16].

3. Formula Development

Together, these three theories ground the development of the DTA formula. Let us look at the complete DTA formula and its derivation:

$$\text{hours}_i = \frac{\text{round}\left(4 \cdot \text{num} \cdot \frac{\text{weight}_i \cdot \left(1 - \frac{\text{score}_i}{100}\right)}{\sum_j \left[\text{weight}_j \cdot \left(1 - \frac{\text{score}_j}{100}\right)\right]}\right)}{4}$$

where,

hours = number of hours one should study on a given topic;

num = total number of hours a student has available to study;

weight = the fractional weight given to the topic (outlined on the official NCLEX website), and

score = the student's percentage score on that given topic.

The subscript *i* represents the topic in question while *j* is designated for all topics in general.

The easiest way to process this formula is to look at it in three steps.

The first step involves weighing the deficit of the score based on the topic:

$$\text{var}_i = \text{weight}_i \cdot \frac{100 - \text{score}_i}{100}$$

where var_i represents the "deficit score" calculated on the premise that the weight of the topic is multiplied by the percentage of deficiency scored on that portion of the practice test.

The second step is to then add all the deficit scores and divide each of the deficit scores by that sum to get a ratio:

$$\text{rat}_i = \frac{\text{var}_i}{\sum_j \text{var}_j}$$

where rat_i represents the ratio, and $\Sigma(\text{var}_j)$ represents the sum of all deficit scores.

Finally, the number of hours one should study on a given topic is calculated as follows:

$$\text{hours}_i = \frac{\text{round}\left(4 \cdot \text{num} \cdot \text{rat}_i\right)}{4}$$

This puts out the number of hours one should study and rounds to the nearest quarter-hour, or 15 minutes. This iteration of DTA is therefore useful for students who study in chunks of 15 minutes.

As an example, let us assume a nursing student took a practice NCLEX and plans on taking another practice test in 2 weeks, setting aside 90 hours to study over those 2 weeks. Out of the exam questions, they answered 50% of the questions under Management of Care correctly. Outside of that category, they answered 90% of the remaining questions correctly. Management of Care constitutes roughly 18% of the test plan distribution [17]. Therefore, the weighted deficit (var_i) equals

$$0.18 \times \left(100 - 50\right) / 100 = 0.09 .$$

The weighted deficit of the remaining topics (constituting 82% of the exam) altogether would equal

$$0.82 \times \left(100 - 90\right) / 100 = 0.082 .$$

The deficit scores are then summed, and each is divided by that sum to get a ratio. For var_i, it would be:

$$\text{rat}_i = 0.09 / \left(0.09 + 0.082\right) = 0.09 / 0.172 = 0.523 .$$

Finally, the number of hours this student should study on Management of Care is calculated as follows:

$$\text{hours}_i = \text{round}\left(4 \times \left(90 \times 0.523\right)\right) / 4 = 188/4 = 47.0 .$$

This individual should therefore study 47 hours out of the 90 available over the next 2 weeks to hypothetically maximize their exam readiness before the next practice test. Importantly, this calculation is based on topic scores that should come from a practice assessment with sufficient questions per category, because unstable topic-level scores may produce misleading allocations. Because the official blueprint provides ranges for category weights, users should base their topic breakdown on any exact numbers provided by their specific practice test. If none are provided, they should use their best estimation with the understanding that these are general guidelines: Selected weights should be normalized to sum to 1, and when practice-test categories do not map cleanly, users should map them to the nearest blueprint category or collapse categories.

3.1. Mathematical Properties

The DTA formula has mathematical properties that have implications for how one studies under a dedicated period. Let us look at the key assumptions for DTA:

$$\sum_j \text{weight}_j = 1$$

$$\text{score}_i \in [0,100]$$

with DTA, we assume that the weighted breakdown of all the exam categories adds up to 100%. The percentage score of each student must range from 0 to 100 percent, meaning they answered every question on that topic incorrectly, they answered every question correctly, or they answered a portion of those questions correctly. Please note that the breakdown of exam categories may be subject to change in the future. We therefore defer commenting on the exact breakdown in this paper.

Now, let D be the total weighted deficits:

$$D = \sum_j \left[\text{weight}_j \cdot \left(1 - \frac{\text{score}_j}{100} \right) \right]$$

The DTA model is therefore well-defined whenever $D > 0$. This means that there must be a deficiency in the practice test performance for there to be a meaningful breakdown of what topics to study.

Let us look at the case of uniform performance. When all scores are equal ($\text{score}_i = \text{score}_j$), the deficit score ($\text{var}_i$) behaves as such:

$$\text{var}_i = \text{weight}_i \cdot \frac{100 - \text{score}_i}{100} \quad \text{and}$$

$$D = \left(1 - \frac{\text{score}_i}{100} \right) \cdot \sum_j \text{weight}_j = \left(1 - \frac{\text{score}_i}{100} \right) \quad \text{therefore,}$$

$$\text{hours}_i = \text{num} \cdot \text{weight}_i$$

In plain language, this means that when the student has no differential information from practice scores, the formula automatically defaults to studying according to the NCLEX blueprint. This is a desirable property, as it means a student with uniformly weak performance ($\text{score}_i = \text{score}_j$) and a student with a uniformly strong performance receive identical relative allocations. The formula uses scores only insofar as there are relative differences across topics.

3.2. Boundary Conditions

To extend DTA to boundary conditions, a complete mastery where $\text{score}_i = 100$ equates to $\text{hours}_i = 0$. This is sensible as it assumes a test taker who performed perfectly on a given topic should not spend any time on that topic but should allocate time on topics that were deficient. A complete deficit where $\text{score}_i = 0$ equates to $\text{var}_i = \text{weight}_i$, so the topic absorbs allocation proportional to the weight on the NCLEX only.

The interesting case is when one has universal mastery, where $\text{score}_j = 100$. If $D = 0$, the formula is undefined. This case is notable because if there is no deficit and $\text{hours}_j = 0$, the formula would suggest that the test taker should not allocate any time to study. Therefore, if $D = 0$, the DTA model should fall back to:

$\text{hours}_i = \text{num} \cdot \text{weight}_i$ (when $D = 0$) which is the default blueprint review.

Students who score perfectly should still do maintenance reviews proportional to test importance. As a practical safeguard for near-mastery scores, the authors recommend a minimum of 1 - 2 hours on topics the test-taker is already comfortable with so that they do not forget key information. If they are studying under the guidance of an instructor, they should defer to the instructor's judgment when small score differences generate highly concentrated study plans.

If only one topic has $\text{score}_i < 100$ and there is a single non-zero deficit, all the study hours flow to that topic. This produces an all-or-nothing allocation that may feel extreme but is mathematically correct under the formula's logic.

At very low D levels ($D \to 0^+$) as students approach mastery, small absolute differences in deficits get amplified into large proportional allocations. In other words, if a student theoretically scores 99% on all topics except for one that was 95%, the formula will allocate a significant chunk of that time to the 95% topic.

3.3. Sensitivity Analysis

For own-score sensitivity, let p_i represent the proportional allocation of topic i, where:

$$p_i = \frac{\text{var}_i}{D}$$

such that

$$\text{var}_i = \text{weight}_i \cdot \frac{100 - \text{score}_i}{100}$$

(Note that p_i is equivalent to the variable rat_i under Formula Development.)

There is an inverse relationship between score and proportional allocation: as score_i increases, this allocation decreases. When examining the mathematical properties of DTA, one may ask: How much does improving topic *i* reduce its own allocation? Let us look at the compact form of the DTA formula:

$$\text{hours}_i = \text{num} \cdot \frac{\text{var}_i}{D}$$

which simplifies to:

$$\text{hours}_i = \text{num} \cdot p_i$$

The inverse relationship between the score on a topic and proportional allocation also applies to the relationship between the score on that topic and the allocated number of hours. As one's score increases, the formula correctly reduces allocated time.

There are two takeaways from this own-score sensitivity: 1) The magnitude of the hours needed to study scales with the weight of that topic. Topics with a high weight are more responsive to score changes, which is desirable. 2) The sensitivity scales inversely with *D*. As overall mastery improves and D shrinks, the formula becomes more sensitive to small score movements, as discussed earlier.

For cross-score sensitivity, one asks: How much does improving topic *i* increase the allocation to topic *j*? When $j \neq i$, improving any topic redistributes time to others in proportion to their existing share. This is also a desirable behavior.

Lastly, the rounding to the quarter-hour is not mandatory, but offers a simplified method of organizing the amount of time one has to dedicate to studying. Quarter-hour rounding can introduce up to 7.5 minutes of rounding error, which means that the rounded sum $\Sigma(\text{hours}_j)$ may not equal num. In addition, there may also be a minimum budget problem if num is relatively small. Given the assumed large value of num when test takers study, this rounding error can largely be ignored as DTA is more of a guided tool and approximation to begin with.

4. Expert Review and Validation

The DTA formula has face validity. The formula was independently reviewed by five doctorates in nursing education or health-related sciences and independently reviewed by two non-health-related professionals: a mathematician and a computer scientist. Experts were chosen based on a combination of convenience and snowball sampling. The five doctorates were selected based on four eligibility criteria: 1) they had to be age 18 or older, 2) be fluent in English, 3) have graduated from doctoral-level training, and 4) have at least 3 years of prior experience with nursing or nursing education. The mathematical and computational soundness of the formula was independently reviewed by two technical reviewers based on three eligibility criteria: 1) they had to be age 18 or older, 2) be fluent in English, and 3) have over a decade of experience in a mathematical or computer programming field.

The chosen experts qualitatively evaluated DTA based on theoretical alignment,

relevance to NCLEX preparation, clarity, feasibility, and completeness. The evaluation was conducted in person, starting with a PowerPoint presentation on the utilitarian framework and grounding in Mastery Learning and Deliberate Practice, followed by a visual of the DTA formula itself with its mathematical derivation and an example of how to use it. This presentation was followed by a roughly 3 - 5-minute Question-and-Answer session, after which the experts were given the following review prompts:

1) How would you assess the theoretical alignment of the utilitarian framework to the DTA formula?

2) How relevant would you say the DTA model is to NCLEX preparation?

3) Is the DTA formula presented clearly?

4) How feasible would it be for a test-taker to use the DTA formula for exam preparation?

5) For completeness, do you have any further suggestions?

6) Finally, do you approve of the DTA formula based on everything that has been shown?

Under theoretical alignment, experts evaluated whether the formula faithfully operationalizes the utilitarian framework. Under NCLEX relevance, experts evaluated whether the construct of deficit-weighted time allocation was appropriate at face value for the target use case. Experts also evaluated whether a nursing educator or student could understand and apply it, and whether it would be implementable in real study planning. For completeness, experts also evaluated whether there were important factors the formula omits that should be present. While there was no rating scale, approval was inferred from responses and all reviewers answered "yes" to Question 6.

All five nursing education experts rated the formula as appropriate on each evaluation dimension, yielding unanimous agreement on theoretical alignment, relevance, clarity, feasibility, and completeness. Both technical reviewers independently confirmed the formula's mathematical correctness and conformance to the specified rounding rule. Qualitative feedback emphasized the formula's relevance not only to nursing student education but also its relevance to other topical educational fronts such as medical school education and the United States Medical Licensing Examination (USMLE) preparation. Experts noted that DTA could in principle generalize to any blueprint-weighted standardized exam. In response to feedback, the piecewise rule for the $D = 0$ case was added and the rounding convention clarified. No experts proposed additional substantive changes to the formula's structure.

In terms of ethical considerations, this DTA model presents a methodological tool that qualifies as IRB-exempt, as it does not constitute human subjects research under 45 CFR 46. Due to small panel size and purposeful non-random sampling, as well as a single-round non-Delphi design, this validation constitutes face validity and expert consensus, not empirical validation. Empirical validation of the formula's effect on NCLEX practice test performance constitutes the next

step in studying the DTA model.

5. Limitations

DTA has limitations, including the linear deficit-to-time assumption. The formula assumes that a student scoring 50% needs twice the time that a student scoring 75% on a similarly weighted topic. DTA does not account for diminishing returns or desirable difficulties [18]. DTA is defensible as a first-order approximation. DTA also does not factor in the sequencing or distribution of time allocated, which would be improved by spaced memory [19]. The quantity of study time is only reliable when considering the quality of study time and baseline ability of the learner. Although DTA is grounded in 20th-century theories, DTA bears relevance to post-COVID applications as outlined in the introduction.

Logistically, the model assumes topic independence, but NCLEX content areas can overlap. The model is highly reliant on practice-test reliability and validity, while the official test blueprint offers an approximate range of percent breakdown rather than fixed ratios. Generalizability beyond the NCLEX is untested.

6. Conclusion

DTA provides guidance for nursing student test-taking improvement during dedicated study hours. DTA does not comment on the quality of study or spaced-repetition but does approximate the amount of recommended time a nursing student test-taker should allocate toward each focused topic given a finite number of hours. DTA is an emerging educational model with theoretical grounding, mathematical justification, face validity and expert consensus.

Author Contributions

Dr. Liu contributed to the conceptualization, methodology, validation, and core contents of this work. Dr. DeLuca contributed to the review, editing, and supervision.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Sherwood, G. (2024) Transforming Education: Developing a Practice-Ready Workforce. *International Journal of Nursing Sciences*, **11**, 159-161. https://doi.org/10.1016/j.ijnss.2024.03.002

[2] Knowles, M.S. (1978) Andragogy: Adult Learning Theory in Perspective. *Community College Review*, **5**, 9-20. https://doi.org/10.1177/009155217800500302

[3] NCSBN (2026) NCLEX Pass Rates. https://www.ncsbn.org/exams/exam-statistics-and-publications/nclex-pass-rates.page

[4] Elkins, N. (2019) Failure to Complete BSN Nursing Programs: Students' Views. https://files.eric.ed.gov/fulltext/EJ1252119.pdf

[5] Xu, H., Chu, Y., Li, X., Hou, R., Tang, W. and Liu, X. (2025) Was the Study Time

Allocation Based on Expectation-Maximization in Value-Test Likelihood Tradeoff Situation? *Psychological Research*, **89**, Article No. 107. https://doi.org/10.1007/s00426-025-02141-0

[6] Almasloukh, K.B., Miner, M., Phillips, K. and Evans, M. (2023) Educational Strategies and Nursing Theory to Prepare Leaners for NCLEX-RN. *Nursing Open*, **10**, 7144-7153. https://doi.org/10.1002/nop2.1998

[7] Cosper, S.M., Callan, R.S. and Anderson, L.S. (2023) Investigating Student and Faculty Perspectives Related to Predictors of NCLEX-RN Success: A Mixed Methods Approach. *Teaching and Learning in Nursing*, **18**, 360-365. https://doi.org/10.1016/j.teln.2023.02.002

[8] Flowers, M., Olenick, M., Maltseva, T., Simon, S., Diez-Sampedro, A. and Allen, L.R. (2021) Academic Factors Predicting NCLEX-RN Success. *Nursing Education Perspectives*, **43**, 112-114. https://doi.org/10.1097/01.nep.0000000000000788

[9] Hinkle, J.F., Bove, L.A., Roberto, A., Arms, T., Rowan, N.L. and Sigmon, L. (2023) An Innovative Nurse Practitioner Curricular Design Using an Adaptive Learning Platform, Adaptive Case Studies, and Telehealth Simulations: A Feasibility Study. *SAGE Open Nursing*, **9**, 1-8.

[10] Gabbard, T. and Romanelli, F. (2021) The Accuracy of Health Professions Students' Self-Assessments Compared to Objective Measures of Competence. *American Journal of Pharmaceutical Education*, **85**, Article 8405. https://doi.org/10.5688/ajpe8405

[11] Liu, M. (2022) The Relationship between Students' Study Time and Academic Performance and Its Practical Significance. *BCP Education & Psychology*, **7**, 412-415. https://doi.org/10.54691/bcpep.v7i.2696

[12] Plant, E.A., Ericsson, K.A., Hill, L. and Asberg, K. (2005) Why Study Time Does Not Predict Grade Point Average across College Students: Implications of Deliberate Practice for Academic Performance. *Contemporary Educational Psychology*, **30**, 96-116. https://doi.org/10.1016/j.cedpsych.2004.06.001

[13] Akpan, B. (2025) Mastery Learning—Benjamin Bloom. In: Akpan, B. and Kennedy, T.J., Eds., *Springer Texts in Education*, Springer, 143-156. https://doi.org/10.1007/978-3-031-81351-1_9

[14] Kulik, C.C., Kulik, J.A. and Bangert-Drowns, R.L. (1990) Effectiveness of Mastery Learning Programs: A Meta-Analysis. *Review of Educational Research*, **60**, 265-299. https://doi.org/10.3102/00346543060002265

[15] Ericsson, K.A., Krampe, R.T. and Tesch-Römer, C. (1993) The Role of Deliberate Practice in the Acquisition of Expert Performance. *Psychological Review*, **100**, 363-406. https://doi.org/10.1037/0033-295x.100.3.363

[16] Platt, A., Allan, J. and Leader, C. (2024) An Exploration of the Use of Deliberate Practice in Team-Centered Healthcare Simulation-Based Education: An Integrative Review. *Clinical Simulation in Nursing*, **94**, Article 101584. https://doi.org/10.1016/j.ecns.2024.101584

[17] NCSBN (2023) NCLEX-RN ® Test Plan. https://www.ncsbn.org/public-files/2023_RN_Test%20Plan_English_FINAL.pdf

[18] Rutherford, S. (2020) Using Desirable Difficulty Concepts to Enhance Durable Learning in Design Education. *Art, Design & Communication in Higher Education*, **19**, 65-79. https://doi.org/10.1386/adch_00014_1

[19] Wollstein, Y. and Jabbour, N. (2023) Spaced Effect Learning and Blunting the Forgetfulness Curve. *Ear, Nose & Throat Journal*, **101**, 42S-46S. https://doi.org/10.1177/01455613231163726