The LENS Algorithm for Introduction to Optometry 4001

Learning Efficiency and Nomenclature Scoring

Justin A. Dang

2024-10-16

Abstract

4001 Introduction to Optometry is a foundational course required for students at NSUOCO. As the field of optometry continues to advance, so too must its educational practices. Recently, the course underwent a shift in faculty, introducing a curriculum that requires students to master an average of 120 medical terms per week. Despite being a one-credit hour course, the workload and study time for Intro to Optometry often exceed those of courses with higher credit hours. To optimize the study process, the LENS (Learning Efficiency and Nomenclature Scoring) algorithm was developed. In conjunction with the tools provided by learnterms.com, this algorithm enhances study efficiency by assessing each term based on its importance, quizability, and difficulty. As a result, the Class of 2028 is able to produce a streamlined word list, reducing redundant study efforts while maximizing retention and performance on quizzes.

Northeastern State University
Oklahoma College of Optometry
Tahlequah, OK

1 Introduction

4001 Introduction to Optometry introduces students to the fundamentals of the profession, with a focus on three key areas: terminology, heritage, and current practices. While heritage and current practices are thoroughly addressed through historical literature and lectures, terminology is a self-directed study component. Each week, students are quizzed on a list of assigned medical terms, with the aim of developing the language proficiency necessary for effective communication in practice.

The course meets once a week for only one hour, so this presents a significant challenge. The medical terms, which are from Optometric Medical Terminology by Handeland and Staroba, require considerable study time when approached manually. An informal survey of the Class of 2028 suggested that students were spending 3 to 4 hours per week to studying, often with unsatisfactory results on assessments. These quizzes demanded perfect spelling of each medical term: after all, spelling matters. Additionally, the terms were distributed via old photocopied PDFs, making efforts to digitize the material for flashcard use arduous.

To address these challenges, the class developed LearnTerms.com, a study tool designed to simplify quiz preparation. The site uses a "type-only" quizzing method, combining root word learning, spelling, and memorization. However, the volume of terms was still overwhelming. As a result, an algorithm was created to strategically reduce the number of terms, ensuring students could focus on core concepts while still mastering essential terminology.

2 Development and Purpose of the LENS Algorithm

LENS stands for Learning Efficiency and Nomenclature Scoring. It has two goals:

1. **Make studying efficient.** This notion prioritizes mastery of concepts in as little time as possible.

2. **Increase quiz scores.** The LENS algorithm has specific considerations to focus on *how* the terms are tested to improve scores. Additionally, rating terms through LENS works to helping students figure out the correct answer to novel questions and untested terms in studying on the actual quiz.

The LENS algorithm may be expressed in the following way:

$$LENS(t_i) = \frac{I(t_i) \times Q(t_i)}{D(t_i)}$$

Let $LENS(t_i)$ be the LENS value of the term t_i, which represents the overall priority of studying this term based on its importance, quizzability, and difficulty.

2.1 Importance

Let $I(t_i)$ represent the relative importance of the term to optometry. After noticing at least one question about an ocular specific term on every quiz, the I factor become highly important in regards to the testing priority of the term. This would make intuitive sense since the course name indicates the subject of study. We assign $I(t_i)$ a value between 0 and 1 based on how closely the term is related to optometry. Terms directly related to the eye or visual condition (e.g. *Myopia*) get a high value, while general medical terms receive a lower value as they are less likely to appear on a quiz (e.g. *Myalgia*).

- High relevance: $I(t_i) \approx 0.8$ to 1.0
- Moderate relevance: $I(t_i) \approx 0.5$ to 0.7
- Low relevance: $I(t_i) \approx 0.2$ to 0.4

2.2 Quizzability

Let $Q(t_i)$ represent how **easily the term can be tested in a quiz or exam format**, especially multiple choice or fill-in-the-blank questions. $Q(t_i)$ is also assigned a value between 0 and 1 based on how straightforward the term is to test. Terms with clear, specific meanings (e.g. *Ophthalmoscope*) that can easily be quizzed get a higher value, while ambiguous or complex terms that are harder to test (e.g. *Dacryocystorhinostomy*) get a lower value. This is based on properties like simplicity, distinctiveness, and whether it's easy to define.

- Easy to quiz: $Q(t_i) \approx 0.7$ to 1.0
- Moderate to quiz: $Q(t_i) \approx 0.4$ to 0.6
- Hard to quiz: $Q(t_i) \approx 0.1$ to 0.3

2.3 Difficulty

Let $D(t_i)$ represent how **difficult the term is to understand or memorize.** More complex or less familiar terms get a higher value. $D(t_i)$ is assigned a value between 0 and 1. Terms that are easier to understand and remember have a lower $D(t_i)$ score (e.g. *Macular*), while harder, more complex terms (due to spelling, technicality, or unfamiliarity) (e.g. *Iliolumbocostoabdominal*) have a higher value.

- Easy to learn: $D(t_i) \approx 0.1$ to 0.3
- Moderate to learn: $D(t_i) \approx 0.4$ to 0.7
- Hard to learn: $D(t_i) \approx 0.8$ to 1.0

2.4 Explanation

The numerator term is comprised of the importance score times the quizzability score.

$$I(t_i) \times Q(t_i)$$

- Importance multiplied by Quizzability gives an overall "usefulness" score for the term in relation to your specific goals (passing the test, focusing on relevant material). This reflects how crucial and testable the term is.
- High I and high Q mean the term is both highly relevant and easy to test, so it should be prioritized in studying.

The denominator stands alone in order to adjust the score based on difficulty. Terms with multiple combining forms and hard spellings were found much less likely to be quizzed.

$$D(t_i)$$

- Dividing by Difficulty penalizes terms that are harder to understand or memorize. This reflects the fact that harder terms take more effort to study, reducing their overall "study value." Terms with higher difficulty have their LENS value lowered because they require more time or effort to learn.
- The higher the difficulty, the smaller the overall LENS value for the term, making it less efficient to study.

- Multiple terms with the same meaning (e.g. *algia vs dynia*) are automatically assigned a score of 0, completely disqualifying them from making the word less. This is because for pick one multiple choice or fill in the blank, it is impossible to take both terms at the same time without marking the other wrong.

A high LENS value means the term is both important and quizzable, but not overly difficult to learn. These terms are highly efficient to study and should be prioritized.

A low LENS value indicates that either the term is not important, hard to quiz on, or very difficult to learn. These terms are less efficient to study and should be deprioritized unless necessary.

2.5 Examples

For Aphakia:

- $I(\text{Aphakia}) = 0.85$: It's very relevant to optometry.
- $Q(\text{Aphakia}) = 0.75$: It's fairly quizzable.
- $D(\text{Aphakia}) = 0.65$: It's moderately difficult to understand and remember.

$LENS(\text{Aphakia}) = \frac{0.85 \times 0.75}{0.65} = 0.98$

For Dacryocystorhinostomy:

- $I(\text{Dacryocystorhinostomy}) = 0.6$: It's somewhat relevant but more specialized.
- $Q(\text{Dacryocystorhinostomy}) = 0.5$: It's harder to quiz on.
- $D(\text{Dacryocystorhinostomy}) = 0.85$: It's quite difficult to learn.

$LENS(\text{Dacryocystorhinostomy}) = \frac{0.6 \times 0.5}{0.85} = 0.35$

3 Impact on Study Efficiency and Outcomes

With a limited sample size and the lack of reliable surveying techniques, this report would not be able to provide a statistically relevant model, especially not one to draw proper conclusions from. However, from limited data, there are promising results.

Analysis of site metrics shows a significant reduction in study time, with students averaging one hour per study session compared to the initially self-reported 3-4 hours pre-LearnTerms. While the platform's "test typing" methodology contributes to this efficiency, the LENS algorithm has provided added optimization by systematically reducing the published terms list by about 16 terms per week. This number grows closer to 30 as the algorithm is tested on more word sets.

The reduction in terms mainly occurs through two mechanisms:

1. Elimination of synonymous terms by automatically assigning a difficulty score of 0 to duplicate meanings, effectively removing redundant study material

2. Application of the LENS algorithm with a conservative threshold score of 0.30

The algorithm demonstrates high selectivity in term retention. It tends to pick ocular-specific terms by scoring a high LENS value. Conversely, terms containing multiple combining forms or redundant meanings typically receive lower scores. These terms may still be in the set if they exceed the threshold value. This conservative approach ensures comprehensive coverage while eliminating genuinely redundant or less relevant material.

The method of assigning these scores is a partly manually and partly automated process. It consists of OCR, scripting, and an LLM to quickly get a small overview. The full details of the weekly score assignment is outside the scope of this paper but may be detailed in future work.

In terms of accuracy to assessments, the algorithm has so far included every term that has been a quiz question despite cutting down on redundant and unquizzable terms.

Week	4	5	6*	7	8	9
Actual Terms #	195	170	202	140	135	145
Adjusted Terms #	195	161	202	118	113	118

*Week 6 data excluded from analysis due to open-note format

On average, the workbook provided an actual terms count of 164. The LENS-adjusted average yielded 141 terms, an average of 16 terms per week. For the first week, the LENS drop threshold has 0.05. This conservative figure increased as the algorithm was tested for feasibility. The drop now holds at 0.30, a figure that has maintained the 100% accuracy of term quiz appearances.

The question remains: has this increased quiz scores? An informal survey suggests yes. But this also could be because of factors like getting used to the format and other considerations that have more to do with appealed points after the fact. Without a proper survey, it's hard to know. And even then the correlation is difficult to assess with such limited data and time.

3.1 Limitations and Future Work

Proper analysis should investigate the impact of term reduction on student performance and consider implementing control groups to validate the algorithm's effectiveness. But seeing as the semester is only so long and the inefficiency of a control group, it is unlikely that proper data will yield actionable results. However, analyzing the algorithm's performance over longer periods could provide insights into benefits over the course of the semester.

There is strong evidence for a correlation between the LearnTerms platform and quiz performance. The same could be said of the platform and time saved studying. In an effort to downsize the terms deck and save even more time, the LENS algorithm provides a tangible start to helping the class succeed in 4001.