Utilizing computational algorithms to innovate learning environment in the pathology classroom

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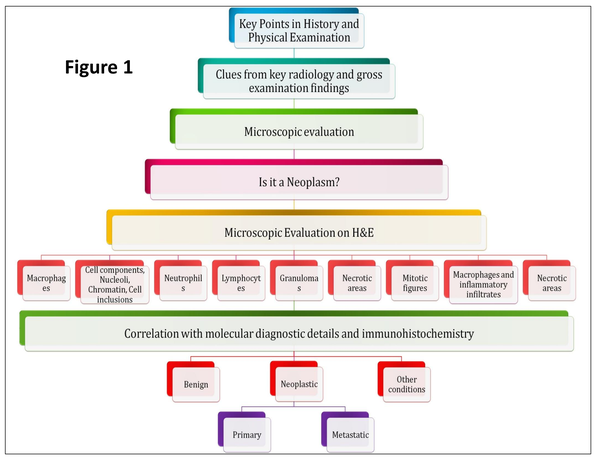
Introduction

- For a generation that must know and do more than ever before, medical educators must include novel strategies that more efficiently aid students in learning how to progressively narrow down the daunting wealth of information. For a future pathologist or physician, one of the most critical attributes required is a step-by-step approach to avoid diagnostic errors.

- We introduced a new teaching strategy employing an algorithmic approach to diagnosis, to promote an organized, sequential, logical thought process, that is conductive and adaptable to the learning process of the students. Algorithms were used to address various topics with the help of predefined categories (Figure 1), and students placed the data meaningfully, to summarize all key aspects and clarify the elements of an otherwise abstract concept. Our algorithm began with case history and clinical examination and moved all the way to meld realms of key points of gross and digital pathology, radiological findings, molecular pathology, immunohistochemistry and relevant lab investigations.

- We gave a preliminary approach to include computational pathology by making these algorithms in the form of executable computer programs. Our aim is to foster creativity in the pathology classroom by enthusing students to design computational algorithms, and bolstering problem-solving skills in clinical case scenarios utilizing a TBL setup.

Figure 1



Material and Methods

- Online resources and the institutional information technology expert assisted with the couple lectures integrated with the pathology curriculum, designed to familiarize the students with the informatics part. These lectures focused on the basic aspects of informatics, necessary for the execution of their Computational Pathology project using SQL & Java interface, to design algorithms and build an elementary database.

- A TBL session was organized where 5 groups were logically divided based on variations in background with respect to informatics. It was ensured that each group had at least one member with a certain experience in the field.

- Small groups were provided with diagnostic data including radiological, annotated gross and microscopic histopathological findings, pathophysiology, immunohistochemistry (IHC) and molecular pathology data woven with clinical case scenarios pertaining to the tumors of CNS, GIT, Musculoskeletal, CVS and Male & Female Genital Tracts. Each group was assigned a system, to work in a TBL format using case vignettes and compile the data provided to design algorithms. The algorithms illustrated the relevant differential diagnosis, identification, treatment, and management of different disease processes and emphasized the significance of relevant information to arrive at the accurate diagnoses. Continuous faculty assessment of student performance was done.

- Each algorithm was evaluated by the faculty, and students were graded on both -- the algorithm made using the computational database, and the one without using it. The grading system was based on the organization of algorithms, accuracy of the layout, linkage of consecutive steps and the deduction of differential diagnosis and final diagnosis.

- The faculty validated the effectiveness and usability of the algorithms by analyzing and correlating the grades in TBL sessions with the block results and cumulative scores. A survey was also conducted among all the students. The computational database compiled by the students was stored for reference by future classes.

Results

- Overall data analysis was analyzed for nonparametric rank correlation using Spearman's rho, which demonstrated a significant positive interaction between iRAT (individual readiness assessment test) scores and student participation in the exercise, as depicted by the cross line ascending from left to right (Figure 2).
- The survey conducted among the students included nine closed items, and employed a Likert scale of 1 to 5, with 5 being Strongly Agree/Excellent and 1 being Strongly Disagree/Poor. Survey results (Figure 3) indicated that students' mean interest level & retention was significantly higher after the TBL exercise.

Figure 2: Correlation between TBL exercises and corresponding student grades on final exams

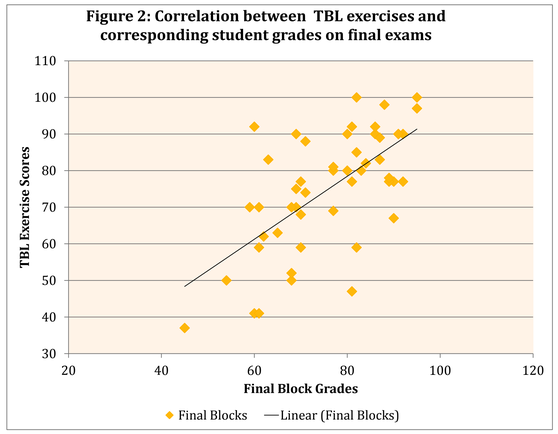
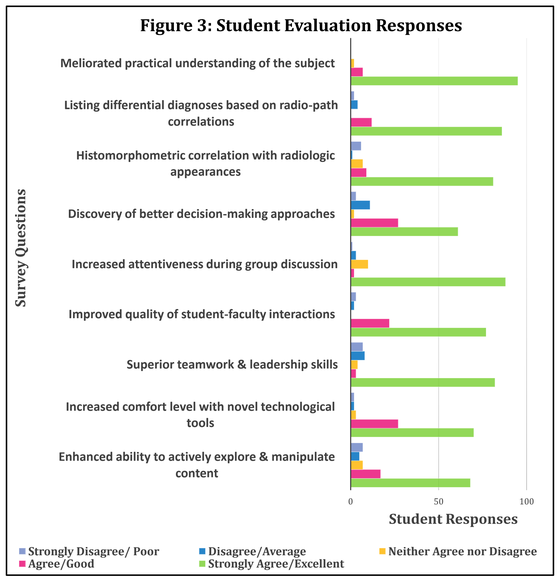


Figure 3: Student Evaluation Responses



Discussion

The mind is not a vessel that needs filling, but wood that needs igniting
- Plutarch

- The traditional expectation from the students to memorize the minutiae is unrealistic; instead, the focus needs to be shifted to understanding how to and how things fit.
- Radio-pathological correlation and molecular pathology, along with a dynamic computational algorithmic approach not only moves the needle but significantly upgrades material retention capabilities and decision-making capacity, which opens the door to a smooth transition into clinical sciences.
- Our algorithms accomplished three main competency areas: disease mechanisms, integration of disease mechanisms to organ systems application of pathology and diagnostic medicine.
- The algorithmic approach executed in a TBL setting not only enables learners to continually discuss, share and strengthen content, but also to redirect their efforts from developing redundant content to selecting the strongest content in creating computational algorithms, which makes them feel empowered to solve problems in medicine even at an early stage in their career.

Conclusion

- In the age when AI algorithms are aiding lab personnel and physicians everyday to make a more comprehensive diagnosis, algorithms introduced early-on, equips learners to take multiple individual steps in their own minds to arrive at the final accurate diagnosis more systematically.
- From an over-reliant passive learning, our efforts to introduce active TBL sessions and computational algorithms helped students achieve thorough retention and better scoring. Students were able to understand the relevance of biomarkers, IHCs, radiology and digital pathology, and it helped them realize what pathology actually has to offer and inspired in many, a keen interest in pathology as a permanent career in the precision medicine era.

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