



The Dynamic Classroom for Medical Education: A Tech-Enabled, Data-Driven Version of the Flipped Classroom

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Abstract

The U.S. healthcare system faces a crisis, especially in low-income and rural areas, due to a projected shortage of 37,800 to 124,000 physicians by 2034, a lack of demographic representation among physicians, and a gap in health sciences students graduating to meet the demand for services. To address these issues, the authors propose a pathway program coupled with a predictive analytics platform, piloted at Ponce Health Sciences University (PHSU) with the MD program & the Master of Science in Medical Sciences (MSMS) program. The 10-year R&D project aims to increase diversity in the physician workforce. This Case Study highlights PHSU's teaching method, the Dynamic Classroom, which is a modified version of the flipped classroom model that uses synchronous class time for low-stakes assessments and real-time evaluations. Students debate quiz questions, identify knowledge gaps, and engage in an active learning environment. Evidence shows comparable USMLE Step 1 and Step 2 performance between pathway and non-pathway students. Despite challenges and costs, the Dynamic Classroom teaching method demonstrates potential for improving medical education and potentially other domains. Future steps include expanding the data set to include new cohorts and developing a network of pathway programs to address physician workforce diversity nationwide.

Keywords: Medical Education; Flipped Classroom; Teaching Method

Abbreviations: PHSU: Ponce Health Sciences University; MSMS: Master of Science in Medical Sciences; UGPA: Undergraduate Grade Point Average; ICS: In-Class Sessions.

Introduction

Three concurrent factors are creating a healthcare crisis in the U.S. First, there is a projected shortage of between 37,800

and 124,000 physicians by 2034, according to Association of American Medical Colleges [1-3]. This includes between 17,800 and 48,000 primary care physicians and between 21,000 and 77,100 non-primary care physicians. Second, there is a lack of equivalent representation in the U.S. in terms of demographics compared to the physician workforce [4,5]. This lack of cultural competency and representation leads to negative impacts on medical outcomes, including

treatment decisions, treatment adherence, and patient health [6,7]. Third, there is a gap between the demand for healthcare professionals, especially in low income and rural areas, compared to the labor supply, specifically the number of healthcare professionals graduating and entering the workforce [8-10].

These three factors are inter-related and range from minor issues, such as longer wait times for appointments with specialists, to major issues, such as not having access to a specialist at all. One solution to address this lack of healthcare professionals, specifically physicians, proposed by the authors is to create a pathway program that allows aspiring physicians an opportunity at a MD year 1 level curriculum. The authors suggest coupling this pathway program with a predictive analytics platform thereby creating an alternative method of evaluating applicants to a medical school. This approach is based on prior research showing that pipeline/pathway programs can be an effective alternative method of accepting students to terminal health science programs [11,12]. Mayrath, et al. [12] describe a 10 year R&D project at Ponce Health Sciences University (PHSU) to launch a pathway program and build a predictive analytics platform with the goal of increasing diversity of the physician workforce [13,14].

Like other LCME accredited medical schools in the U.S., PHSU uses standard evaluation criteria such as the MCAT, undergraduate grade point average (UGPA), undergraduate science grade point average (UsciGPA), interviews, etc. However, PHSU also accepts students from the institution's Master of Science in Medical Sciences (MSMS) program. Launched in 2015-2016, MSMS graduates make up between 20-30% of PHSU's MD cohorts. MSMS is unique because the program uses the same curriculum as the PHSU year 1 MD curriculum except for 3 courses. We consider the MSMS to be a longitudinal performance assessment program because students must demonstrate mastery of the year 1 medical curriculum. Research shows that a longitudinal performance assessment can be a better measure of a student's knowledge, skills, and abilities compared with a one-time snapshot of knowledge, such as the MCAT or SAT exam [15,16].

The PHSU MD admissions committee will waive the MCAT for an applicant from the MSMS program that meets all admissions criteria related to GPAs, interviewed well, demonstrated mastery during the MSMS program, and is predicted to pass the USMLE Step 1 based on the predictive analytics platform. The platform was created & validated by PHSU's technology partner Tiber Health Innovation. This Case Study builds upon the authors' previous work by sharing the teaching method & instructional design approach used by PHSU's MD and MSMS programs. In 2015-2016, PHSU switched from a traditional lecture-based teaching method

to a modified version of the flipped classroom. Medical education is evolving as schools move to integrated curricula and add more technology to support teaching and learning. Many medical schools have adopted a flipped classroom teaching method; whereby, students watch lectures videos before attending class meetings face-2-face.

Research on using the flipped classroom approach for undergraduate medical education has shown benefits with students expressing strong satisfaction and generally preferring the method compared to lecture-based instruction [17]. Further, researchers have also found increased student motivation, higher levels of cognitive processing, and more faculty interest as a result of implementing the flipped classroom in undergraduate medical education [18]. However, there is a lack of research on how technology, specifically an audience response quiz system, integrated into the flipped classroom approach can inform faculty & administrators with data.

Hypothesis

We hypothesize the students will benefit from implementing a modified version of the flipped classroom for undergraduate medical education as measured by performance on the USMLE Step 1 and Step 2 exams. This modified version includes frequent low stakes, formative assessments combined with think-pair-share discussions after difficult quiz questions.

Purpose

The purpose of the Case Study is to share lessons learned & findings that will hopefully help other medical schools seeking to add more innovation to their MD curriculum. Further, this Case Study builds on the work PHSU is doing to address the lack of diversity in the physician workforce. This report is focused not just on how PHSU MD flipped classroom approach, but how to create an active learning environment that engages students in daily low stakes, formative assessments. Having MD undergraduate students doing quizzes on an almost daily basis does two important things: (a) helps students identify their knowledge gaps.

Method

Setting

PHSU is a Middle States Commission on Higher Education-accredited institution that offers 15 health science programs, including a Liaison Committee on Medical Education-accredited medical program. PHSU has campuses in Puerto Rico and St. Louis, Missouri. The main campus was established in Ponce, Puerto Rico, more than 45 years ago.

Sample

PHSU admitted 693 medical students between the academic years 2016-2017 and 2021-2022. A total of 156 (22.0%) graduated from the MSMS or pathway program students and 537 (78.0%) were non-MSMS or non-pathway students. The mean age was 23 years for both groups. The findings reported in this study are based on PHSU medical school data before the St. Louis campus was opened in fall 2022. Thus, students in the data set are Puerto Rican or Hispanic.

Intervention – The Dynamic Classroom

The Dynamic Classroom has students watch lecture videos prior to participating in In-Class Sessions (ICS). Students' video viewership is tracked and used for reports provided to students and faculty. ICS takes place synchronously (classroom/virtual) and is where the most active learning takes place. During ICS, instructors administer quizzes using an audience response system, iClicker Cloud. Instructors ask students to individually answer one quiz question at a time. The instructor dynamically adjusts based on the percentage of students that correctly answer the question. If only 30% of students answer a question correctly, then the instructor will ask students to get into small groups and discuss the answer. After the teams have debated for a few minutes, the instructor asks students to take a second attempt at the same question.

Most often, the percentage of students that answer the question correctly increases on the second attempt. However, if not, the instructor can remediate with an explanation. ICS has three important benefits. First, students are being active learners. They are taking low-stakes quizzes, debating in small groups, and receiving immediate feedback. These instructional activities are aligned with the top levels of Bloom's taxonomy – create, evaluate, and analyze. Second, faculty benefit by having real-time, formative assessment data. The instructor knows whether the class understands a topic or not, which allows the instructor to dynamically adjust instruction. Third, ICS Quiz data is captured daily and used for early alerts. Quiz scores are pushed to Canvas Gradebooks for students, TAs, & faculty.

Evaluation Plan

Quantitative measures used to evaluate the R&D project included MCAT, UGPA, USMLE Step 1, and USMLE Step 2 data.

Results

Data for PHSU medical school cohorts that started between 2015-2016 and 2020-2021 was used to compare

MSMS and Non-MSMS groups. A significant difference was found when comparing mean MCAT scores between Non-MSMS (mean score, 497.5) and MSMS (mean score, 487.0) groups ($P = .0085$). A significant difference was also found when comparing the mean undergraduate grade point averages (GPAs) between Non-MSMS (mean GPA, 3.66) and MSMS (mean GPA, 3.47) groups ($P = .0031$). No differences were found when comparing the mean USMLE Step 1 scores for both groups: Non-MSMS (mean score, 220.2) and MSMS (mean score, 218.6) students ($P = 0.56$). No differences were found when comparing the mean USMLE Step 2 scores for both groups: Non-MSMS (mean score, 235.2) and MSMS (mean score, 232.8) students ($P = 0.29$). A 2-tailed, unpaired 2-sample t test assuming unequal variances was used to test for significance.

Discussion

The authors compared two groups of PHSU MD students: students accepted directly or Non-MSMS and students that were accepted from the MSMS (the pathway program). There was a statistically significant difference between the two groups on MCAT and UGPA; however, there was no statistically significant difference when comparing the two groups on the USMLE Step 1 and Step 2 scores. This finding is important because it shows that there are other MD admissions methods that can be considered other than relying on the MCAT as a cut score. In other words, there is a large population of potential physicians that could address the three problems stated earlier; however, these potential physicians are blocked by a high stakes exam with known biases [7].

Data showed that MSMS students had lower MCAT scores and lower UGPAs compared with their Non-MSMS peers; nonetheless, MSMS students performed comparably on the USMLE Step 1 exam and the USMLE Step 2 exams. The PHSU medical program accepted pathway students with MCAT scores as low as 480 to 490; however, these pathway students benefited from their well-established prior knowledge going into their second year after taking year 1 of medical school twice (once during the MSMS program and then again during year 1 of medical school). We believe that the Dynamic Classroom teaching method and Early Alert system help to explain this finding, e.g., creating an active learning environment supported with formative data & reports help to engage students and remediate.

Lecture Video Production

Requiring faculty to change their teaching method after they have been teaching for many years is challenging. Possibly more difficult is requiring faculty that enjoy lecturing to stop and record their lectures in a studio in front of a

camera. And possibly even more challenging is asking faculty that are mostly native Spanish speakers to record in English. These challenges and more were present when PHSU made the transition to the Dynamic Classroom in 2015-2016. The process continues today with updating a library of over 800 undergraduate medical education videos for years 1 and 2. The outline below details lessons learned and best practices from a project to update the MD lecture videos:

- **Project Manager (PM)** - An experienced & efficient PM is needed to coordinate the multiple stages of the video production process for hundreds of videos across dozens of faculty.
- **Multimedia Learning Principles** - A set of design principles has been researched extensively by Dr. Rich Mayer and provide guidelines for how to create effective lecture videos [19]. PHSU uses these techniques, such as signaling to draw a student's attention to a specific part of an image.
- **Quality Matters (QM)** - The PHSU instructional design team has been trained and certified on Quality Matters course development standards. PHSU updated the course design for the MD curriculum during the 2023-2024 based on student feedback and QM standards.
- **Image Replacement** - A tedious process was undertaken for each video whereby a Subject Matter Expert (SME) would review the slides for a lecture video that was planning to be updated. The SME would look for any images that were not from the PHSU library. If there was a question about the right to use an image, the SME would look for a replacement image that PHSU has the rights to use.
- **Bilingual** - When updating their lecture videos, faculty are allowed to speak in English or Spanish. The video team has a multi-step process for translating videos that includes creating a transcript in the original language, translating the transcript, having a SME review and edit, re-recording the audio in the second language, and editing the video to create the second language version.
- **Video collaboration platforms** - The video team managed dozens of videos every week and had to get feedback from faculty. This process could be slow and confusing when using email. Thus, the video team adopted a video platform to help with collecting feedback and approvals from faculty, specifically Frame.io. The video team included video editors at two different campuses, one in St. Louis, MO and one in Ponce, PR. The team used the platform Lucid Link to share files & video assets.

Findings and Implications

The Case Study described a modified version of the flipped classroom teaching method-the Dynamic Classroom.

This teaching approach was applied to the PHSU MD curriculum which is also used for a MSMS degree. For both MD and MSMS, our data suggests that students benefit from the active learning environment created by using the Dynamic Classroom teaching method. Faculty and TAs utilize the data created by the teaching method for daily low stakes assessments that inform an early alert system. This helps to identify which students are falling behind as early as week 1 in a semester.

Conclusion

Limitations

The primary limitations of this study are sample size and generalizability. The findings in this report are limited to PHSU medical students in Puerto Rico; thus, the findings may not be generalizable to other medical school programs. A second limitation is that implementing the personnel and technology platforms described in this report can present a substantial cost for a university.

Next Steps

We are excited to continue this line of research in multiple areas. We are expanding our data set to include new cohorts such as the PHSU St. Louis campus, which opened in 2022. On a larger scale, to address the lack of diversity in the physician workforce, we recommend that medical schools create a network of pathway programs. This pathway program network could help address the diversity issue by creating a standardized evaluation framework for comparing students based on a shared set of assessments. PHSU has started this initiative by partnering with universities around the United States that are seeking a pathway program, such as the MSMS, for their undergraduate students in premedicine, biology, and other fields. We are seeking more university partners to join our effort of increasing diversity in the physician workforce through pathway programs and predictive analytics.

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References

1. Association of American Medical Colleges (2021) The Complexities of Physician Supply and Demand: Projections From 2019 to 2034.
2. Association of American Medical Colleges (2019) Diversity in medicine: Facts and figures 2019.
3. Ly DP, Essien UR, Olenski AR, Jena AB (2022) Affirmative Action Bans and Enrollment of Students From Underrepresented Racial and Ethnic Groups in U.S. Public Medical Schools. *Ann Intern Med* 175(6): 873-878.
4. Shahriar AA, Puram VV, Miller JM, Sagi V, Castañón-Gonzalez LA, et al. (2022) Socio economic diversity of the matriculating US medical student body by race, ethnicity, and sex, 2017-2019. *JAMA Netw Open* 5(3): e222621.
5. Hall WJ, Chapman MV, Lee KM, Merino TW, Thomas TW, et al. (2015) Implicit racial/ethnic bias among health care professionals and its influence on health care outcomes: A systematic review. *Am J Public Health* 105(12): e60-e76.
6. Cooper LA, Roter DL (2003) Patient-provider communication: the effect of race and ethnicity on process and outcomes of healthcare. In: *Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care*. National Academies Press, Washington, DC pp: 552-593.
7. McKinsey & Company (2023) How health systems and educators can work to close the talent gap.
8. Navarro-Martínez O, Igual-García J, Traver-Salcedo V (2023) Bridging the educational gap in terms of digital competences between healthcare institutions' demands and professionals' needs. *BMC Nursing* 22(1): 144.
9. Leider JP, Yeager VA, Kirkland C, Krasna H, Bork RH, et al. (2023) The state of the US public health workforce: ongoing challenges and future directions. *Annu Rev Public Health* 44: 323-341.
10. Clarke-Midura J, Dede C (2010) Assessment, technology, and change. *J Res Technol Educ* 42(3):309-328.
11. Lane S, Stone CA (2006) Performance assessment. In: *Educational measurement*, 4th edition, pp: 387-431.
12. Mayrath MC, Fontanez D, Abdelbaset F, Lenihan B, Lenihan DV (2023) Increasing Diversity in the Physician Workforce: Pathway Programs and Predictive Analytics. *Acad Med* 98(10): 1154-1158.
13. Mayrath MC, Abdelbaset F, Fontanez D, Lenihan B, Lenihan DV (2024) Predictive Analytics & Pathway Programs: A New Model for MD Admissions to Increase Diversity. AAMC Conference: Southern Group on Education Affairs (SGEA) 2019, Houston, TX, United States.
14. Lucey CR, Saguil A (2020) The consequences of structural racism on MCAT Scores and medical school admissions: the past is prologue. *Acad Med* 95(3): 351-356.
15. Formicola AJ, D'Abreu KC, Tedesco LA (2010) Underrepresented minority dental student recruitment and enrollment programs: an overview from the dental Pipeline program. *J Dent Educ* 74(10 Suppl): S67-S73.
16. Ramnanan CJ, Pound LD (2017) Advances in medical education and practice: student perceptions of the flipped classroom. *Adv Med Educ Pract* 8: 63-73.
17. Phillips J, Wiesbauer F (2022) The flipped classroom in medical education: A new standard in teaching. *Trends Anaesth Crit Care* 42: 4-8.
18. Mayer RE (2010) Applying the science of learning to medical education. *Med Educ* 44(6): 543-549.
19. Issa N, Schuller M, Santacaterina S, Shapiro M, Wang E, et al. (2011) Applying multimedia design principles enhances learning in medical education. *Med Educ* 45(8): 818-826.