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First-Year Experience Implementing an Adaptive Learning Platform for First- and Second-Year Medical Students at the Lake Erie College of Osteopathic Medicine

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Context: The Lake Erie College of Osteopathic Medicine (LECOM) is a large, diverse medical school spread across 3 campuses, which makes it challenging to deliver comparable learning experiences to all students. Osmosis is a Web and mobile application that can integrate with a variety of existing curricula and, through its content creation and sharing features, can foster student cohesion in an online environment.

Objective: To analyze the first year of use for the Osmosis platform among LECOM students at each campus and to identify barriers to this use.

Methods: Medical education at LECOM is delivered across 3 campus locations using 3 main pathways: the lecture-discussion, problem-based learning, and directed-study pathways. Beginning in the 2016-2017 academic year, all LECOM first-year medical students could use the Osmosis platform free of charge; second-year students were informed about the platform but were required to pay for a subscription. For all students, engagement metrics were tracked within the platform, and periodic student surveys and informal student feedback supplemented these metrics.

Results: Of 1135 LECOM students, 567 (50%) signed up for an account, including 416 (73%) of 573 first-year and 151 (27%) of 562 second-year students. In aggregate, students created 17,901 items and answered 123,050 practice questions and flashcards. Student use of the platform varied considerably, with the highest use at the Erie campus, where the platform was championed by faculty, and among a portion of second-year students preparing for board examinations. Some students were "superusers"; 2 students completed more than 20,000 items, and 5 created more than 1000 items each. The greatest barriers to use of the platform were preferences for previous study methods and lack of time to learn new study habits.

Conclusion: Although the use of the platform across LECOM campuses was uneven, it was greatest when there was overt support by faculty and when students were already motivated to use the platform. The lessons learned during the first year of the program will be used to improve use of the platform. The authors offer their insights into this new technology.

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The Lake Erie College of Osteopathic Medicine (LECOM) is the largest medical school in the United States by student population, enrolling approximately 580 medical students per year across 3 campuses in 5 distinct learning pathways with 3 major curricular modalities. Although this program structure affords many advantages, such as a large and diverse student body and options for geographic locations and curricula that match student preferences, it also presents challenges. For example, it can be difficult to maintain a unified learning community that spans these geographic boundaries and distinctive curricula. Ensuring comparable learning experiences and outcomes for all students across 3 campuses is a priority at LECOM but can strain administrative and academic support resources. For medical students, it is particularly important for medical schools to provide adequate support for high-stakes national board examinations, such as the Comprehensive Osteopathic Medical Licensing Examination-USA and the United States Medical Licensing Examination series. Academic support is essential to alleviate student anxiety and stress,[1] which can worsen performance on such examinations.[2]

When attending medical education conferences, LECOM faculty members (A.H. and K.M.) were exposed to an array of presentations describing the benefits of applying lessons from cognitive sciences to make learning more efficient.[3] They subsequently identified a new technology that could meet their needs. This adaptive learning platform, called Osmosis (https://www.osmosis.org), was created by Johns Hopkins medical students in 2012 and is accessible by means of Web and mobile applications.[4,5] Since its introduction, it has accumulated 100,000 student users at more than 750 medical schools worldwide. The platform works with each medical school's curriculum. Students securely upload curricular documents, such as lecture slides and handouts, which can be linked to dates on their curriculum schedule. Documents can be read by the platform's natural language processing algorithms. The program then recommends relevant formative assessments, such as flashcards and board-style questions, as well as board study materials (eg, First Aid study materials), high-quality open education resources (eg, Open Osmosis videos), patient videos, visual mnemonics (eg, Picmonic study aids), and 3-dimensional anatomy simulators.

Content includes that commonly found in allopathic programs as well as content tagged for osteopathic principles and practice. In addition to delivering this content, the platform can apply methods proved in cognitive sciences research to enhance learning and retention, such as spaced repetition and interleaving,[6] by using machine learning algorithms that analyze student use and by "pushing" appropriate content at the appropriate time. This function makes learning more efficient by helping students focus on areas in which their knowledge is deficient and decrease redundancy for more familiar content areas. The platform also fosters a social environment by allowing students to enter into study groups and create and share resources, such as flashcards and multiple-choice questions, with others in these groups or more broadly. Students can provide feedback on items that are created and shared with each other, which could further enhance peer learning.

After initial discussions with the Osmosis team, LECOM faculty members collaborated with them to submit a proposal for internal grant funding. The proposal was successful and supported Osmosis subscriptions for all first-year medical students at LECOM, well as resources for data collection and analysis as part of a pilot evaluation. In this article, we report on LECOM's first year of experience with this platform, including student metrics and feedback, and we describe LECOM's lessons learned and future directions.

Methods

Participants and Setting

This project used a nonexperimental design with a convenience sample of 1135 first- and second-year osteopathic medical students during the 2016-2017 academic

year across 3 campuses of LECOM to assess adoption and use of, as well as barriers to using, the Osmosis platform. The 3 campuses of LECOM are located in Erie and Greensburg, Pennsylvania, and Bradenton, Florida. The 3 major learning pathways are the lecture-discussion pathway (LDP), the problem-based learning pathway (PBL), and the directed-study pathway (DSP). Two additional curricular pathways include the accelerated physician's assistant pathway and the primary care scholars pathway (PCSP). The accelerated physician's assistant pathway and PCSP are accelerated pathways in which the actual curriculum is delivered via 1 of the 3 main curricular pathways (LDP, PBL, or DSP) and will thus not be discussed further in this article. The LDP is a traditional curricular pathway using a combination of lectures, workshops, and laboratories presented by both basic science and clinical faculty during the preclinical curriculum. The PBL is delivered via small group interactions in which students work through a series of patient cases to facilitate their learning. The DSP is similar to the LDP in its curricular design, but the content is delivered predominantly in highly structured modules that require students to read the required textbooks and assimilate the information on their own with less instruction time from the basic and clinical science faculty. The DSP is the curricular route for the PCSP, in which students have an accelerated curriculum of 3 years and a commitment to primary care.

In Erie, approximately 180 students per year participate in the LDP, compared with about 40 each for the PBL and DSP. Problem-based learning is the curricular model at both the Greensburg and Bradenton campuses. Preclinical education at all campuses and in all pathways is facilitated by qualified basic science and clinical medical educators. Students complete clinical clerkships at training sites throughout the country in their third and fourth years.

Implementation

A complimentary 12-month subscription to the Osmosis platform was offered to first-year students (class of 2020) on all 3 campuses and in all pathways near the start of the first semester in the 2016-2017 academic year. The second-year students (class of 2019) were also made aware of the platform but were required to pay for subscriptions, which were similar in cost to other common board preparation materials. Support from Osmosis staff was available throughout the implementation period. The support team was responsive and worked with our students who had questions on use and applications. For example, our students wanted highlighting to be made available within the program, and that function was added within 2 days. At the Erie campus, faculty leaders encouraged and supported use of the platform throughout the year. Attempts to recruit staff to lead implementation efforts at the Greensburg and Bradenton campuses were unsuccessful.

Evaluation

Engagement metrics were tracked for the 2016-2017 academic year within the Osmosis platform for all students who created an account across the 3 campuses. Descriptive statistics were used to measure use compared with total student population by campus. Metrics included (1) the number of student subscribers, (2) the number of questions and flashcards answered, (3) the number of questions and flashcards created by users, and (4) the number of notes created by users. The first-year students across all 3 campuses were surveyed in August, December, and May regarding their curricular preferences. Surveys were sent electronically through SurveyMonkey to student email accounts with an invitation to participate in a voluntary, confidential survey and with links to the survey. After the initial email invitation, 2 follow-up reminders were sent to students who had not yet responded to increase participation rates. The surveys were determined to be exempt from institutional review board review. All 3 survey administrations included a general open-ended item ("Please write any other comments you would like to share with us in the box below"), which some students used to comment on the platform. In the final survey, 3 open-ended, platform-specific items were included ("If you do not

use Osmosis, why not?" "I was motivated to use Osmosis because . . . ," and "What do you like best about Osmosis?"). Anecdotal voluntary feedback from students at the Erie campus was collected by 2 of the authors (A.H. and K.M.) throughout the course of the year. Basic descriptive statistics were tabulated for quantitative data. Informal qualitative feedback from students was summarized based on our recall of discussions.

Results

Engagement Metrics

Of 1135 LECOM students, 567 (50%) created an Osmosis account. The proportion creating accounts was greater among first-year students (416 of 573 [73%]), who were given free subscriptions, than among second-year students (151 of 562 [27%]), who were required to pay. The proportions of students signing up for accounts also varied across campuses and pathways and were higher at the Erie campus (388 of 528 [73%]) than at the Greensburg (85 of 212 [40%]) or Bradenton (94 of 395 [24%]) campus. Engagement metrics for the platform were computed and are shown in the **Table**.

In aggregate, students created 17,901 items and answered 123,050 practice questions and flashcards. Within pathways, the use was highest among second-year students at the Erie campus in the LDP and DSP, who on average completed more than 700 items each. There was also great variation among individuals; 2 students completed more than 20,000 items each, and 6 completed between 5000 and 11,000 items each. Although only 84 students generated new items, some students created numerous items, with 5 students creating more than 1000 items each.

Survey and Individual Student Feedback

Survey response rates varied according to when the survey was administered and by campus. The overall response rate in August was 230 of 536 (43%), with rates by campus as follows: Erie, 172 of 268 (64%); Bradenton, 26 of 133 (20%); and Greensburg, 32 of 133 (24%). In December, the respective rates were 71 of 536 (13%) (overall), 59 of 268 (22%) (Erie), 10 of 133 (8%) (Bradenton), and 2 of 133 (2%) (Greensburg), and in May they were 123 of 536 (23%) (overall), 82 of 268 (31%) (Erie), 22 of 133 (17%) (Bradenton), and 19 of 133 (14%) (Greensburg). Positive student comments in response to open-ended items commonly identified collaborative options, board-style multiple-choice questions, and note-taking functions. During informal discussions, students identified by lead faculty (A.H. and K.M.) as being among the highest users of the platform reported an increase in their average test scores and an increase in confidence when approaching course examinations. Moderate users also reported that the use of the platform helped them stay organized and on target in their studies.

Barriers to use reported by students in surveys and in feedback to lead faculty included limited time to learn new study skills, technical issues integrating the platform with other applications they use, and preferences for other study habits (eg, preference for using a "tactile resource," such as a textbook).

Discussion

In our first year of implementing an innovative educational technology, we found that adoption and use varied by campus and educational pathway and among individual students. Our experience and evaluation data are providing useful guidance for optimizing implementation of the new platform at LECOM and may be useful to others seeking to innovate with their own medical students.

New technologies hold legitimate promise for revolutionizing learning,[7] and institutions are increasingly purchasing these resources for students. However, faculty often overestimate the extent to which students will adopt and use new technologies,[8] and there is little research-based evidence to guide effective implementation.[9] To our knowledge, only 2 studies have explicitly evaluated adoption of educational

Table.
Osmosis Engagement Metrics for First- and Second-Year Students at LECOM, 2016-2017 Academic Year

Engagement Metric[a]	Erie Campus			Greensburg Campus	Bradenton Campus
	LDP	DSP	PBL		
Class of 2020 (First-Year Students)					
Osmosis users/total, No. (%)	178/185 (96)	42/42 (100)	36/39 (92)	74/112 (66)	86/195 (44)
Items answered					
Total No.	18,756	4064	3953	1256	3048
Mean	105.4	96.8	109.8	17.0	35.4
Items created					
Total No.	7548	1330	207	1011	3
Mean	42.4	31.7	5.8	13.7	<0.1
Notes taken					
Total No.	43,807	9	8	458	0
Mean	246.1	0.2	0.2	6.2	0
Class of 2019 (Second-Year Students)					
Osmosis users/total, No. (%)	92/188 (49)	27/41 (66)	13/33 (39)	11/100 (11)	8/200 (4)
Items answered					
Total No.	66,302	19,025	1576	4665	405
Mean	720.7	704.6	121.2	424.1	50.6
Items created					
Total No.	7116	345	3	337	1
Mean	77.3	12.8	0.2	30.6	0.1
Notes taken					
Total No.	17,408	4078	0	4	0
Mean	189.2	151.0	0	0.4	0

[a] For both classes of students, including all campuses and pathways, the total numbers were as follows: 567 Osmosis users/1135 total students (50%); 123,050 total items answered (mean, 217.0); 17,901 total items created (mean, 31.6); and 65,772 total notes taken (mean, 116.0).

Abbreviations: DSP, directed-study pathway; LDP, lecture-discussion pathway; LECOM, Lake Erie College of Osteopathic Medicine; PBL, problem-based learning pathway.

applications among undergraduate medical students. One study[10] evaluated the use of an application that provided mobile access to a digital family medicine textbook, finding higher use among female students, students who expected benefit, and those who used smartphones. The second study,[9] which included 6787 Osmosis users from 2014 to 2015, found that persistent use of the platform was associated with paying for a subscription, being part of an online group, and using a mobile device. At LECOM, although more individuals signed up for an account when it was provided for free, we also found higher use among students who

paid for a subscription. The study by Menon et al[9] could not determine why paid subscribers would use the technology more, but they suggested that subscribing could be a marker for behavioral intent, an important feature of technology adoption models.[11] We found that many high-intensity users were second-year medical students using the platform to prepare for board examinations, indicating that this specific intention may have encouraged their use of the application.

Analyzing data across LECOM's campuses afforded unique comparisons. For example, most new accounts were created among students at the Erie campus, and these students also provided the most responses to our evaluation surveys. We believe this difference occurred primarily owing to the presence of faculty champions at this campus and support that was lacking at the Greensburg and Bradenton campuses. Previous studies of technology adoption have pointed to the importance of "facilitating conditions," defined as the "consumers' perceptions of the resources and support available to perform a behavior."[12] In medical education, faculty champions may encourage this perception among students. Future studies may be able to tailor existing technology adoption frameworks to medical education settings.

In contrast to simple flashcard or quizzing software, the Osmosis platform captures a variety of behaviors, demonstrating that individual students in different settings study in different ways. We found that some students gravitated to answering questions, some to generating content, and others to taking notes. Some students even became "superusers," answering or creating thousands of items. Cognitive sciences research consistently shows that formative assessments enhance learning, whereas passive learning behaviors, such as rereading materials, provides the illusion of learning without fostering knowledge acquisition and retention.[6] Medical education studies corroborate this research, consistently showing that scores on high-stakes board examinations are correlated with the number of formative assessment items completed in preparation.[13-16] Additional studies examining why students used different features of the platform would help encourage student engagement and behaviors likely to enhance learning.

The most consistent barrier to adoption and use of the platform reported by students was lack of time to learn how to use the application. Surprisingly little is known about how medical students adapt to medical school academic environments. This may be a legacy of the traditional curricular model, in which the first 2 years of medical school were largely classroom and laboratory based and may have resembled the college learning experience. However, today's first-year medical school learning environments are likely to differ considerably from college environments, because nearly all curricula include early clinical experience, and many include activities intended to promote self-regulated learning skills. Moreover, students are now offered a bewildering array of supplementary resources to choose from. In this context, it is not surprising that students reported having little time to learn new study habits, and they likely have less time and energy to devote to creating and sharing formative assessment items. Investing in resources that introduce new study techniques and simplifying students' choices of study resources may be promising ways to improve their learning habits, and this approach is consistent with the osteopathic principle of caring for mind, body, and spirit.

Finally, although our focus was on implementing the Osmosis platform to benefit students, we discovered an unintended consequence of faculty engagement with the product's team. Our impression before this experience, perhaps influenced by published reports,[17,18] was that representatives of the medical education "industry" might not make good partners, leading to strained relationships. However, in working with the platform's team, we found that our goals of improving medical student education were aligned and that our relationship was symbiotic. Osmosis team members helped us obtain grants that funded initial implementation and scholarship at LECOM, and they connected us with faculty at another institution, with whom we

successfully applied for another competitive research grant. Faculty members at LECOM and other institutions using the same platform have begun working together as a community of innovators in medical education, looking ahead to additional fruitful collaborations. The Osmosis team has benefited as well by receiving regular feedback that makes its platform more beneficial for other medical student users.

Limitations

Our work has some important limitations. Response rates to the surveys we administered were variable and very low outside the Erie campus. We intentionally selected open-ended items to analyze because we found recurrent themes among student responses, but such low response rates can limit the generalizability of our findings. Moreover, although we summarized feedback from conversations with students, we did not conduct structured interviews or focus group sessions that would have lent themselves to formal qualitative analysis. Finally, during the project we discovered the importance of faculty champions in supporting implementation, but we were unable to rigorously evaluate faculty perceptions or engagement.

Lessons Learned and Future Directions

The Osmosis platform continues to be used by medical students at LECOM. In the 2017-2018 academic year, many first-year students signed up for the platform, and usage for the class of 2020 has been sustained into their second year of medical school, despite having to pay for access to the platform. Based on the experiences throughout the Osmosis network of schools, we have learned that although faculty champions are essential to student adoption and use of the platform, student champions may be even more important. Our current group of LECOM students includes a few student champions who strongly recommend the program to their classmates, leading to new subscribers and new platform-based study groups. Greater engagement of students and faculty may also lead to more fruitful evaluations—with greater student engagement, we may be able to glean additional insights into initial barriers to adoption. Systematic research into factors that predict adoption and use of technologies, especially those relating to faculty perception and use of technologies in teaching, factors encouraging students to become champions of the platform, and aspects of the platform that improve learning outcomes, such as knowledge acquisition, retention, and performance on examinations, will help optimize its implementation and performance.

Conclusion

Our foray at LECOM into using technology to encourage continuous innovation in our curriculum provided immediate benefits for some students and a rich learning experience for faculty. Lessons learned in the process are being used to improve implementation. We are currently sharing our experience through the Osmosis network, which should allow more institutions to capitalize on the potential of this technology, and we hope that sharing our lessons regarding the nuances of technology adoption in medical education will benefit other medical educators more generally.

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Author Contributions

All authors provided substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; all authors drafted the article or revised it critically for important intellectual content; all authors gave final approval of the version of the article to be published; and all authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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