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Abstract

Medical students have self-reported the importance of online resources for learning course materials and for preparing for USMLE exams. However, reports describing the actual usage of online resources by medical students are less abundant. In this article, we report the actual usage of institutionally-provided online resources by first-year students from the Medical College of Wisconsin-Central Wisconsin regional campus. From 2017 through 2022, different cohorts of first-year students were provided access to three different online supplemental resources: Draw It to Know It, Osmosis, and Anatomy.TV (powered by Primal Pictures). Most of the students in the study accessed one or more online resources, but the extent to which students accessed each of these materials was highly variable. Based on self-reported data we expected more students to use these resources to a greater degree. Our results suggest that rather than purchasing institutional licenses to online resources, institutional funds might be better used in another manner, possibly by providing students a scholarship/stipend towards an individual license to an online resource for which the student can provide evidence of extensive use.

Introduction

The Medical College of Wisconsin-Central Wisconsin (MCW-CW) is a regional medical school campus located in Wausau, WI that matriculated its first class of students in July 2016. The mission of the campus is the development of community-focused physicians who will meet the healthcare needs of Central Wisconsin and surrounding regions. Through an accelerated curriculum, MCW-CW students can complete their entire medical school education in three years on the CW campus. Briefly, the initial two years are composed of preclinical courses, discipline- and organ-specific science courses, and clinical experiences. USMLE Step 1 is typically taken by CW students at the end of the second year. During the third year, CW students are focused on completing their longitudinal integrated clerkships, acting internships, and USMLE Step 2CK.

The first-year basic science lectures for Clinical Human Anatomy (CHA) I & II, Foundations of Human Behavior, Infectious Agents and Host Immunity, Medical Neuroscience, Molecules to Cells, Physiology, and Principles of Drug Action are largely delivered

virtually to the CW campus by faculty members located on the main campus in Milwaukee. Other course elements including clinically-based discussions and labs are delivered locally on the regional campus by a team of MD and PhD teaching faculty. These courses are graded on a satisfactory/unsatisfactory scale. MCW-CW students have the option of watching lectures through a live streaming format from a classroom on the MCW-CW campus or from any location with a Wi-Fi connection. Alternatively, MCW-CW students can view recordings of the lectures. Our analyses indicate that students who access lectures in real time perform better than students who watched recorded lectures [1]. CW students can virtually interact with Milwaukee teaching faculty and staff or in person with regional campus faculty for one-on-one assistance.

Students at MCW and other institutions self-report frequent use of online resources to assist their learning of concepts presented in medical school [2]. Consequently, MCW-CW provided online resources to CW students to facilitate learning of basic science concepts and prepare for USMLE examinations.

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Students were provided access to three online resources: Draw It to Know It (DITKI), Osmosis, and Anatomy.TV (powered by Primal Pictures). DITKI (<https://www.drawittoknowit.com>) is an online resource that contains videos and practice questions for foundational and clinical concepts. An additional advantage of the DITKI platform is the ability of students to draw concepts on their electronic devices to reinforce concepts through an active learning process. Osmosis (<https://www.osmosis.org/home/dashboard>) is an online resource that contains videos, flash cards, and practice questions covering foundational and clinical topics. Anatomy.TV (<https://www.anatomy.tv/titles>) focuses on structure identification including 3D imaging resources, quizzing functions, and a wealth of anatomy and physiology content. We chose DITKI for its active learning feature, Osmosis for the depth and breadth of medical school topics appropriate for M1 students, and Anatomy.TV for its self-assessment functionality and three-dimensional anatomical projections. In this article, we present data on student usage of these three institutionally-provided supplemental online resources.

Methods

Institutional subscriptions were purchased by MCW to web-based platforms: DITKI, Osmosis, and Anatomy.TV. MCW-CW students were informed of their access to these resources by e-mail with directions on how to activate their accounts. Student usage of DITKI, Osmosis, and Anatomy.TV resources was monitored with analytics provided within each platform.

We analyzed student usage of DITKI by total videos accessed and videos accessed by foundational scientific discipline, determining the mean and standard deviation for the number of videos accessed per student within each discipline and determining the range of videos accessed. We also assessed if there was a correlation between student academic performance and number of DITKI videos watched using linear regression and the effect on a student's academic performance within the foundational science disciplines.

We analyzed Osmosis usage by determining the percent of students that used any Osmosis resources

(videos, quiz questions, and flash cards), the mean and standard deviation for the number of Osmosis materials utilized per student, and the range of Osmosis materials used per student, and investigated if there was a correlation between academic performance and number of Osmosis videos watched by linear regression.

A two-tailed t-test was used to determine statistical significance between two groups, and an ANOVA was used to determine statistical significance between three or more groups.

Student usage of Anatomy.TV during the 2018-19 academic year was determined simply by frequency of modules viewed per student.

This study was approved by the Medical College of Wisconsin Institutional Review Board (IRB).

Results

Student Usage of DITKI Resources: DITKI utilization data are presented in Tables 1, 2, and 3. When analyzing total usage of DITKI videos, 92.6% of the students watched at least one DITKI video (Table 1) and the average number of total videos viewed was 56 (Table 2).

Table 1. Percent of Students Watching One or More DITKI Videos

Discipline	X _{≥1}
All Disciplines n=27	92.6%
Anatomy n=27	77.8%
Biochemistry n=27	40.7%
Embryology n=27	18.5%
Physiology n=27	48.1%
Neuroscience n=27	66.7%
Immunology n=27	33.3%

When analyzing individual scientific disciplines from within the DITKI content, we observed the percentage of students that watched at least one DITKI video ranged from 18.5% to 77.8% (Table 1). The mean number of videos watched per student in each scientific discipline ranged from 3-13 (Table 2), and there is no statistical difference between these values (Table 3).

Table 2. Mean, Standard Deviation, and Range for Number of DITKI Videos Watched within Each Discipline

Discipline	Mean	Std dev	Range	R ²
All Disciplines n=27	56	66	0-259	0.009
Anatomy n=27	11	16	0-68	0.007
Biochemistry n=27	8	16	0-59	0.02
Embryology n=27	3	7	0-23	ND ^a
Physiology n=27	13	22	0-86	0.002
Neuroscience n=27	12	17	0-56	0.004
Immunology n=27	9	25	0-116	0.2

ND^a There is not an acceptable measure of academic performance for embryology topics to compare to DITKI embryology video usage.

Table 3. Statistical Analysis for Use of DITKI Videos by Scientific Discipline

F-statistic value	P-value	Significance Level
1.21	0.31	0.05

We hypothesized that there could be a correlation between academic performance and number of DITKI videos viewed, and investigated this hypothesis by linear regression. The R² values ranged from 0.004 to 0.2, demonstrating that for this cohort there was not a correlation between academic performance and number of DITKI videos viewed (Table 2).

Student Usage of Osmosis Resources: Osmosis usage data are presented in Tables 4-11, showing that 89.5% of students watched at least one Osmosis video for the 2020-21 cohort and 81.0% for the 2021-22 cohort (Table 4). The mean number of videos watched was 35 for the 2020-21 cohort and 21 for the 2021-22 cohort (Table 5). We found no correlation between academic performance and number of Osmosis videos watched. The R² values were 0.2 for the 2020-21 cohort and 0.06 for the 2021-22 cohort, demonstrating that there was not a correlation between academic performance and number of Osmosis videos watched (Table 5). Furthermore, there is no statistical difference between the mean number of Osmosis videos watched by these two cohorts (Table 6). We extended this analysis to investigate if there is a statistical difference between the means of Osmosis videos watched and the mean for total DITKI videos watched (Table 6). This analysis indicated that there is no statistical difference between the 2020-21 Osmosis cohort and the DITKI cohort, but there is a statistical difference between the 2021-22 Osmosis cohort and the DITKI cohort (Table 6).

Table 4. Percent of Students Watching One or More Osmosis Videos

Cohort	X _{≥1}
2020-21 n=19	89.5%
2021-22 n=21	81%

Table 5. Mean, Standard Deviation and Range for Number of Osmosis Videos Watched

Cohort	Mean	Std dev.	Range	R ²
2020-21 n=19	35	35	0-117	0.2
2021-22 n=21	21	31	0-131	0.06

Table 6. Statistical Analysis between Osmosis Cohorts and the DITKI Cohort

Cohort 1	Cohort 2	Two-tailed P value
2020-21 Osmosis	2021-22 Osmosis	0.17
2020-21 Osmosis	DITKI	0.27
2021-22 Osmosis	DITKI	0.03 ^a

^aStatistically significant difference for the usage mean number of videos watched per student between these two cohorts.

With respect to the usage of Osmosis practice questions, the percentage of students attempting at least one question was 5.3% for the 2020-21 cohort and 33.3% for the 2021-22 cohort (Table 7). The average number of practice questions attempted was 6 for the 2020-21 cohort and 97 for the 2021-22 cohort (Table 8).

Table 7. Percent of Students Answering at Least One Osmosis Practice Question

Cohort	$X \geq 1$
2020-21 n=19	5.3%
2021-22 n=21	33.3%

Table 8. Mean, Standard Deviation, and Range for Number of Osmosis Questions Attempted

Cohort	Mean	Std dev	Range
2020-21 n=19	6	24	0-106
2021-22 n=21	97	439	0-2013

For Osmosis flash cards, the percentage of students viewing at least one Osmosis flash card was 63.2% for the 2020-21 cohort and 42.9% for the 2021-22 cohort (Table 9). The average number of Osmosis flash cards viewed was 1,584 for the 2020-21 cohort and 327 for

the 2021-22 cohort (Table 10). There was no statistical difference between these two cohorts for the mean number of quiz questions attempted or the mean number of flash cards viewed (Table 11).

Table 9. Percent of Students Utilizing at Least One Osmosis Flash Card

Cohort	$X \geq 1$
2020-21 n=19	63.2%
2021-22 n=21	42.9%

Table 10. Mean, Standard Deviation, and Range for Number of Osmosis Flash Cards Viewed

Cohort	Mean	Std dev.	Range
2020-21 n=19	1584	6337	0-28572
2021-22 n=21	327	1396	0-6416

Table 11. Statistical Analysis between Osmosis Cohorts for Mean Number of Osmosis Quiz Questions and Flash Cards

Cohort 1	Cohort 2	Osmosis Resource	Two-tailed P value
2020-21 Osmosis	2021-22 Osmosis	Quiz questions	0.37
2020-21 Osmosis	2021-22 Osmosis	Flash cards	0.39

Student Usage of Anatomy.TV Resources: Clinical Human Anatomy at MCW is broken into two courses: CHA I and CHA II. CHA I is broken into three blocks consisting of the upper limb, thorax/GI, and lower limb, while CHA II is focused on the head and neck, and this is the order in which the content is covered in these two courses. The student usage of Anatomy.TV during the 2018-19 academic year is presented in Table 12. In CHA I, 98% of the students viewed at least one Anatomy.TV module related to the upper limb; however, usage of any Anatomy.TV module dropped to 39% during the thorax/GI block, 21% for the lower limb, and 18% for head and neck. The low usage during CHA II was surprising given that

material covered in this course is historically the most difficult anatomy content to master at MCW.

Table 12. Percent of Students Viewing at Least One Session of Anatomy.TV.

Content	Content Order	Percent of Students
Upper Limb	1 st	98%
Thorax/GI	2 nd	38%
Lower Limb	3 rd	21%
Head & Neck	4 th	18%

Discussion

Based on self-reported data from medical students, online resources outside the curriculum are popular for assisting students in solidifying concepts from the foundational science curriculum in preparation for USMLE study. Surveys of medical students have reported that upwards of 90% of medical students use online resources [2, 3] during the foundational sciences. MCW-CW provided access to three different online platforms: DITKI, Osmosis, and Anatomy-TV. Some 81-98% of MCW-CW first-year students used DITKI, Osmosis, and Anatomy.TV resources at least once, but usage was highly variable. Usage was highest in courses where instructors referenced specific resources.

The perceived usefulness of each resource was often not as we expected. For example, a steady decline in accessing Anatomy.TV was noted from the beginning of CHA I through CHA II, despite the course material becoming more challenging. Use of other resources also did not conform to predicted use patterns. This could be related to several factors that will require further study to determine. It is possible that students may have greater comfort with assimilating course material as they progress, or greater comfort in accessing faculty instructors. Simultaneously starting multiple new courses and adapting to the new courses may also consume more student study time than previously believed. Students may have found the questions associated with some resources too easy or too difficult, or that questions did not accurately represent the material covered in their course work. They may have also found that the work involved in accessing the materials exceeded the benefits acquired. Further work is necessary to better

understand the reasons for observed utilization patterns.

Medical students frequently express the desire for access to more USMLE Step 1 style practice questions, both from teaching faculty and online resources [4]. Online resources are numerous and can be costly, and medical students are largely responsible for the cost of purchasing access to online resources. Personal preference and peer opinion or recommendation may weigh more heavily than faculty recommendation or institutional availability. Students may also feel the need to pay to access more than one resource to ensure coverage of all modalities for study. Upwards of 70% of medical students report limited resources for essentials, and it has therefore been suggested that medical schools provide access to online resources as a component of tuition [3].

In order to make a decision about using institutional resources for the purchase of supplemental study materials, we looked at data for three online platforms. Our data showed that students viewed 0-26 DITKI videos per month, viewed 0-13 Osmosis videos per month and attempted 0-201 Osmosis practice questions per month and/or viewed 0-2,857 Osmosis flash cards per month. Based on the observed wide variation in use, we find that it is a challenge for faculty to predict the products or platforms that individual students may find valuable, and that single resources are unlikely to be equally utilized by all students. Our data indicate that rather than having faculty select a limited number of specific online resources, a more cost-effective strategy may be providing reimbursement via a stipend/scholarship to individual students who demonstrate extensive use of an online resource of the student's choosing. Challenges with this approach include determining thresholds for what constitutes enough usage to qualify for reimbursement, difficulty assisting students in identifying one resource that best meets their needs among the myriad of products available for purchase, and limits on faculty time helping students maximally use these resources.

There is no doubt that medical students rely on and benefit from the multitude of online resources available to them. It is also evident that student

preferences for different online resources are highly variable. Assisting students in finding the resources that best meet their needs without unnecessary expense to the student or the institution is a growing challenge as these resources continue to proliferate. We acknowledge that the data presented in this manuscript represents a small sample size of students and a limited sample of available online platforms. However, we feel that this data will stimulate more research and discussion related to this growing topic. We look forward to future reports from medical schools detailing student usage of online resources, whether student-selected or provided to students with institutional resources.

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