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Digital Flashcards and the MCAT: Insights from Current Medical Students on Essential Study Resources

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Abstract

Background

Anki is a digital flashcard program that utilizes spaced repetition and is widely used among medical students preparing for the United States Medical Licensing Examination (USMLE). Likely due to this association, Anki has gained significant popularity among pre-medical students studying for the Medical College Admission Test (MCAT). While previous studies have demonstrated a positive correlation between Anki use and USMLE outcomes, its effectiveness in MCAT preparation has not yet been explored. Thus, our study aimed to investigate the relationship between Anki usage and MCAT outcomes by surveying current medical students.

Methods

An anonymous survey was sent to two cohorts of first-year medical students at Saint Louis University School of Medicine. Respondents were asked details regarding their MCAT scores, the study resources they used, and their perceived usefulness of those resources. Anki users were then asked a series of follow-up questions regarding their degree of usage.

Results

The initial number of responses was 159 out of 358 students, yielding a response rate of 44.4%. Of these, 50 were removed for incompleteness, and an additional 11 responses met exclusion criteria - yielding 98 final responses. There was no statistically significant difference in composite MCAT scores between Anki users (514.8, 95% CI: 510.7–518.9) and non-Anki users (514.2, 95% CI: 509.1–519.3). Despite these findings, 84.8% of Anki users reported that it contributed to their understanding of MCAT content, and 97.8% said they would recommend Anki to other students preparing for the exam.

Conclusion

Our findings contrast with previous studies that have demonstrated a positive correlation between Anki use and USMLE performance. This discrepancy may be explained by the fundamental differences in the format and content of the exams, wherein the USMLE may place greater emphasis on pattern recognition and active recall than the MCAT. Limitations of our study may include the population, which does not include medical students at other institutions or students who took the MCAT but were not accepted into medical school. Therefore, future studies may improve the reliability of their findings by querying a wider population of students to capture the study habits of MCAT examinees more accurately.

Introduction

Each year in the United States, approximately 85,000 students take the Medical College Admissions Test (MCAT), a 7.5 hour long multiple choice exam that tests students' knowledge across a wide range of college-level sciences with the aim to assess their readiness for the academic demands of medical school. The MCAT exam is comprised of 230 total questions distributed across four sections: Chemical and Physical Foundations of Biological Systems, Critical Analysis and Reasoning Skills, Biological and Biochemical Foundations of Living Systems, and Psychological, Social, and Biological Foundations of Behavior. On any given exam, test takers may be expected to analyze detailed science experiments and apply their knowledge of anatomy, genetics, biochemistry, physics, psychology, or sociology to correctly answer each question.

While challenging, the MCAT exam remains one of the most critically important elements of the medical school application process. The MCAT exam acts as a metric by which members of medical school admissions committees may predict the likelihood of a given applicant achieving academic success as a medical student. In one multi-institutional study conducted by Hanson et al., and the American Association of Medical Colleges (AAMC), composite MCAT scores were found to have a medium to large correlation with outcomes in the pre-clinical curriculum, United States Medical Licensing Exam (USMLE) Step 1 and Step 2 CK scores, clerkship exam scores, and clerkship grade point averages (GPAs) among medical students [1]. Thus, admissions officials across the US and Canada continually cite the MCAT as the most important factor alongside undergraduate GPAs in determining which applicants to interview and offer acceptances to [2]. For instance, according to the AAMC, applicants with MCAT scores in the range of 510–513 had a 25.7% greater chance of gaining admission to an MD-granting school than students with scores in the 502–505 range, independent of GPA [3]. With the process of gaining admission to medical school becoming more challenging each year, achieving a competitive MCAT score remains one of the most important ways for applicants to set themselves up for success.

While textbooks are commonly used, some of the other most popular study resources used by students preparing for the MCAT – namely in the form of practice questions and digital flashcards – utilize the principles of retrieval-based practice and spaced repetition. Retrieval practice, which is the process of actively retrieving information from memory during the study process, has been shown to be a highly effective method of maximizing long-term retention of the studied material when compared to other methods of studying that do not involve retrieval, such as rereading or rewatching study material [4–7]. Similarly, spaced repetition is a learning technique in which information is reviewed in increasing intervals over time to strengthen long-lasting recall [8]. In addition to its proven efficacy in improving memory, spaced repetition has been shown to enhance the transfer of knowledge between similar scenarios [9,10]. One digital flashcard program used by students preparing for the MCAT, *Anki*, utilizes both spaced repetition and retrieval-based practice in a free, open-source flashcard format – allowing students to either create their own flashcards or download flashcards other users have made.

Anki's recent increase in attention among pre-medical students preparing for the MCAT may be due in part to its rapid growth in popularity among medical students preparing for the USMLE. Studies have previously demonstrated a positive association between the usage of Anki and USMLE exam scores – with Anki users scoring an average of 5.49 points higher on the USMLE Step 1 exam compared to non-Anki users [11]. The MCAT exam, which bears resemblance to the USMLE in its degree of content overlap, is a strong predictor of performance on the USMLE Step 1 exam and possesses a correlation coefficient of 0.59 [1,12]. Despite the available evidence of the impact of Anki on USMLE outcomes, little is known regarding Anki usage and its relationship to the MCAT in students seeking admission to medical school. Thus, our study aimed to investigate the association between Anki and subsequent outcomes on the MCAT exam. Given the predictive nature of the MCAT on medical student performance and USMLE outcomes – along with the known positive correlation between the use of Anki and USMLE scores – we hypothesize that the utilization of Anki will be associated with increased MCAT scores.

Methods

Survey creation

An anonymous survey was built in Qualtrics XM [Appendix A]. Components of the survey asked respondents about their educational backgrounds, details regarding their MCAT scores, the resources they used to study during their MCAT preparation, and their subjective assessments of the usefulness of those resources. After individual study resources were selected on the survey, respondents were given follow-up questions and were asked to rate how much they believed those particular resources helped them with achieving their MCAT score, rated as either "very helpful," "somewhat helpful," or "not helpful." Students were also asked whether or not they would recommend the individual resources they selected to future students preparing for the exam. Respondents who indicated that they were Anki users were asked a series of follow-up questions regarding their degree of Anki usage, including the number of days per week and the average number of hours per day they spent using it.

Survey administration

An anonymous link to the Qualtrics XM survey, along with a copy of the Saint Louis University School of Medicine Internal Review Board (IRB) approval document, were sent via email to two cohorts of first-year medical students at the Saint Louis University School of Medicine, totaling 358 students. Participating cohorts included the class of 2027 and the class of 2028 when they were each first-year medical students. Students were not offered an incentive to complete the survey, and their responses were kept confidential. Each survey remained active for a total of 6 weeks, and one reminder was sent via email during the fourth week.

Statistical analysis

All statistical analyses were completed using Stata (StataCorp, College Station, TX, USA) after dividing respondents into 2 cohorts: those who reported using Anki and those who reported not using Anki as a study resource. Standard frequency analyses were used to describe responses to the survey, and data were reported as numbers and percentages of respondents to a particular question. Chi-squared testing was utilized for categorical variables, while continuous data was analyzed using two-tailed t-tests to identify associations and significant differences in groups. P-values < 0.05 were used to identify statistical significance.

Results

We received 87 responses out of the 182 students from the class of 2027 (47.8% response rate) and 72 responses out of 176 students from the class of 2028 (40.9% response rate) – totaling 159 responses. Of these, 50 responses were not included in the final analysis due to incompletion. Eleven responses from students who identified as part of the Saint Louis University Medical Scholars Program — an early-assurance program offered to Saint Louis University undergraduates — were excluded from our analysis given the unique circumstances surrounding their MCAT score requirements. Hence, the final number of responses included in our study was 98, with 57 from the class of 2027 (58.2%) and 41 from the class of 2028 (41.8%).

Anki Usage and MCAT Performance

Among responses from the class of 2027, 27 out of 57 (47.4%) respondents indicated that they used Anki in their MCAT preparation, while 19 out of 41 (46.3%) respondents in the class of 2028 indicated that they used Anki – totaling 46 respondents reporting that they used Anki while studying (46.9%). Anki users were asked to estimate their average weekly usage, with 69.5% of Anki users reporting using it between 5–7 days per week. The average number of hours spent on Anki per day was 1.8 (± 0.77).

No statistically significant difference was found between the composite MCAT scores of Anki users (514.8, 95% CI 510.7-518.9) versus non-Anki users (514.2, 95% CI 509.1-519.3). The length of time required to prepare for the MCAT was also similar between Anki and non-Anki users, with an average of 3.83 (95% CI 2.23–5.43) and 3.96 (95% CI 1.96–5.96) months spent studying between the two groups respectively. Additionally, there was no significant difference between Anki and non-Anki users in terms of the number of students that retook the exam (7 retakes in the Anki group vs. 11 retakes in the non-Anki group, p = 0.360). Furthermore, when frequent (5–7 days per week) and infrequent (1–4 days per week) Anki users were compared by their composite MCAT scores, no statistically significant difference was found between the two groups (514.7 vs. 515.1, p = 0.375). Despite these findings, 84.8% of Anki users reported that Anki contributed to their understand of content for the MCAT, 91.3% reported that it helped them retain information throughout their course of studying, 93.5% reported that they planned to use Anki in medical school, and 97.8% reported that they would recommend Anki to other students preparing for the MCAT.

Table 1
Difference in the highest composite MCAT score, study duration in months, and number of MCAT retakes between Anki and non-Anki users.

	Anki users (n = 46)	Non-Anki users (n = 52)	P-value
Highest composite MCAT Score	514.8 (± 4.1)	514.2 (± 5.1)	0.251
Study duration (months)	3.83 (± 1.6)	3.96 (± 2.0)	0.360
Number of MCAT retakes	7 (15.2%)	11 (21.2%)	0.449

Other Commonly Used Resources

Apart from Anki itself, Anki and non-Anki users utilized similar resources during their preparation for the MCAT – with UWorld and Quizlet being two notable exceptions [Table 2]. Anki users reported using UWorld – an online source of passage-based practice questions – at a higher rate than non-Anki users (58.7% vs. 30.8%, p = 0.005). Alternatively, non-Anki users used Quizlet – a free digital flashcard program without integrated spaced repetition – at a higher rate than Anki users (15.4% vs. 2.2% respectively, p = 0.024).

The most commonly used MCAT study resources reported by students include the AAMC Full Length Exams (93.9%), Kaplan MCAT Review Books (66.3%), the AAMC Section Bank (62.2%), the AAMC Question Pack (59.2%), and Anki (46.9%). The least commonly used resources included The Princeton Review MCAT Prep Course (2.0%), Altius Full Length Exams (7.1%), The Princeton Review MCAT Review Books (9.2%), The Princeton Review Full Length Exams (9.2%), and Quizlet (9.2%) [Table 2]. When respondents were asked to rate how helpful they found the resources they used in their preparation to be, AAMC Full Length Exams (100%), the AAMC Section Bank (98.3%), UWorld (97.6%), Blueprint Full Length Exams (96.2%), and Anki (95.6%) were rated by the students that indicated they used these resources as being either “very helpful” or “somewhat helpful.” The Kaplan MCAT Prep Course (90.9%), Kaplan Full Length Exams (89.2%), Kaplan MCAT Review Books (84.4%), Quizlet (77.8%), and hand-made paper flashcards (70%) were among the study materials given the fewest “very helpful” or “somewhat helpful” designations by the respondents that used those resources [Table 3].

Table 2
Utilization rates of different MCAT study resources, arranged from most to least commonly used.

	All (n = 98)	Anki users (n = 46)	Non-Anki users (n = 52)	P-value
AAMC Full Length Exams	92 (93.9%)	45 (97.8%)	47 (90.4%)	0.125
Kaplan MCAT Review Books	65 (66.3%)	27 (58.7%)	38 (73.1%)	0.133
AAMC Section Bank	61 (62.2%)	31 (67.4%)	30 (57.7%)	0.323
AAMC Question Packs	58 (59.2%)	30 (65.2%)	28 (53.9%)	0.253
UWorld	43 (43.9%)	27 (58.7%)	16 (30.8%)	0.005
Kaplan Full Length Exams	38 (38.8%)	14 (30.4%)	24 (46.2%)	0.111
Blueprint Full Length Exams	27 (27.6%)	14 (30.4%)	13 (25.0%)	0.548
Kaplan MCAT Prep Course	11 (11.2%)	5 (10.9%)	6 (11.5%)	0.917
Paper flashcards	10 (10.2%)	3 (6.5%)	7 (13.5%)	0.257
The Princeton Review Full Length Exams	9 (9.2%)	4 (8.7%)	5 (9.6%)	0.875
Quizlet	9 (9.2%)	1 (2.2%)	8 (15.4%)	0.024
The Princeton Review MCAT Review Books	9 (9.2%)	4 (8.7%)	5 (9.6%)	0.875
Altius Full Length Exams	7 (7.1%)	4 (8.7%)	3 (5.8%)	0.575
The Princeton Review MCAT Prep Course	2 (2.0%)	1 (2.2%)	1 (1.9%)	0.93
Other	19 (19.4%)	9 (19.6%)	10 (19.2%)	0.967

Table 3
Student perceptions of and likelihood to recommend different MCAT study resources, arranged from resources perceived as most to least helpful. Helpful was defined as responses of “very helpful” or “somewhat helpful.” Not helpful was defined as responses of “not helpful.”

	Helpful	Not Helpful	Would recommend to future students
Anki	43 (95.6%)	2 (4.4%)	45 (97.8%)
AAMC Full Length Exams	90 (100%)	0 (0%)	88 (98.9%)
Kaplan MCAT Review Books	54 (84.4%)	10 (15.6%)	44 (91.7%)
AAMC Section Bank	59 (98.3%)	1 (1.7%)	56 (94.9%)
AAMC Question Packs	52 (91.2%)	5 (8.8%)	49 (87.5%)
UWorld	40 (97.6%)	1 (2.4%)	40 (97.6%)
Kaplan Full Length Exams	33 (89.2%)	4 (10.8%)	26 (72.2%)
Blueprint Full Length Exams	25 (96.2%)	1 (3.9%)	25 (96.2%)
Kaplan MCAT Prep Course	10 (90.9%)	1 (9.1%)	8 (72.7%)
Paper flashcards	7 (70%)	3 (30%)	4 (40.0%)
The Princeton Review Full Length Exams	9 (100%)	0 (0%)	6 (66.7%)
Quizlet	7 (77.8%)	2 (22.2%)	5 (55.6%)
The Princeton Review MCAT Review Books	9 (100%)	0 (0%)	7 (77.8%)
Altius Full Length Exams	7 (100%)	0 (0%)	7 (100%)
The Princeton Review MCAT Prep Course	2 (100%)	0 (0%)	1 (50.0%)

Discussion

In stark contrast with the available evidence of Anki usage and USMLE outcomes among medical students, our study demonstrates that Anki has no statistically significant impact on MCAT outcomes among the students that completed our survey. Though the MCAT and USMLE share many similarities, our findings may be explained by the inherent differences between these two exams. The MCAT exam,

which presents questions in a passage-based format, often requires test-takers to analyze information within the context of unfamiliar science experiments – thus primarily testing students' adaptive reasoning skills. On the contrary, the USMLE Step 1 exam tests for competence in the basic medical sciences by presenting questions in the form of clinical vignettes. The authors of this manuscript feel that the nature of the USMLE Step 1 exam – testing examinees on the scientific principles of common patient presentations – may require test-takers to utilize pattern recognition and recall to a greater degree than the MCAT exam does, which instead more commonly requires synthesis of new information. Anki, which reinforces memory through the presentation of discrete facts in a flashcard format, may thus prove to be more useful for examinations that require a greater degree of recall. Another alternative explanation for this discrepancy may lie within Anki's spaced repetition algorithm, which provides its greatest utility to users looking to maximize their memory over a period of many months to years. In contrast to the USMLE Step 1, which medical students commonly spend the duration of their pre-clinical coursework preparing for, students studying for the MCAT require much shorter study periods and thus may not be fully utilizing Anki's algorithm [13].

Our study is limited by its population, which only includes students who successfully matriculated into medical school at one institution. In other words, it does not take into account the experiences of a large portion of pre-medical students who took the MCAT but did not gain admission into medical school or those who attended other medical schools. Knowing the MCAT preparation strategies and performance metrics of pre-medical students – not just those who were successful in their application process – could provide more valuable insights into the true role Anki may play in MCAT preparation, and thus may warrant further investigation in future studies. Surveying first-year medical students, as opposed to pre-medical students, also poses a risk of recall bias given the duration between the times at which the MCAT exam was taken and the survey was administered. Additionally, our findings may reflect a degree of reporting bias given our response rate, voluntary participation in the survey, and lack of verification of MCAT scores and study habits. Although use of Anki did not demonstrate an advantage between the two cohorts we surveyed, the use of Anki might be less prevalent among students who did not matriculate to medical school. Our survey demonstrated that Anki is one tool, of many, that successful students use. It would not be surprising to find that students who were unsuccessful in matriculating to medical school were not as familiar with or have access to Anki and other commonly used resources. Future studies may improve the reliability of these findings by incentivizing a higher response rate and querying a wider population of students, which should include pre-medical students, to capture the study habits of MCAT examinees more accurately.

The competition between applicants seeking to gain admission to medical school in the United States continues to become fiercer with each passing year. Between the years 2001–2005 and 2011–2015, application rates per 100,000 US citizens increased from 57.2 to 69.0 respectively, with corresponding matriculation rates failing to increase in proportion [14]. In addition to the other components of the application, scoring highly on the MCAT exam – which requires a wide breadth of scientific knowledge – acts as a means by which students can set themselves apart from other applicants. Thus, in a landscape

where even small differences in scores can make the difference between acceptance and rejection, it is imperative that students use their study time prioritizing resources that have been proven to work. The utilization of question banks and full-length practice exams, which comprise the majority of the highest rated resources on our survey, have been shown in numerous studies to improve outcomes on standardized exams in a dose-dependent relationship and thus may provide more benefit to students looking to maximize their MCAT scores [15–18]. Based on our study results, Anki use is common among students who successfully matriculated to medical school, and appears to be a tool used in a successful study strategy for the MCAT. Anki does not appear superior to other study tools, but also does not appear inferior to other study tools. At best, it is one viable option of many. Additionally, 59 of 98 respondents (60.2%) reported the use of flashcards during their study period, whether in the form of Anki, Quizlet, or paper flashcards. Of these, 55 of the 59 flashcard users (93.2%) used them in a digital format. This finding serves as not only a testament to the tried-and-true utility of flashcards in traditional methods of learning, but also adds to the growing evidence of the wide-spread usage of digital flashcards among healthcare professionals [19].

Though our study found no significant association between the usage of Anki and outcomes on the MCAT, the majority of Anki users rated it as being a highly valuable study tool in their preparation and indicated that they would have used it again if need be. While empiric evidence may exist regarding optimal learning techniques, this finding further underscores the highly individualized nature of studying. A study resource that may provide exceptional benefit to one student may conversely be of no use to another, and thus, true success on examinations likely requires that students experiment with various resources to find the ones that work best for them.

Conclusion

Anki, a digital flashcard program that utilizes spaced repetition in a flashcard format, has rapidly grown in popularity among students preparing for the MCAT exam. In contrast to the known association between Anki usage and USMLE outcomes among medical students, this study found no statistically significant association between Anki usage and MCAT outcomes. This discrepancy may lie within the fundamental differences between the two exams, wherein the USMLE may require active recall and pattern recognition to a greater degree than the MCAT exam does – thus better utilizing Anki's algorithm. The findings of our study provide insight into the utility of popular MCAT resources in a landscape of otherwise limited literature, and thus may prove useful to future students seeking to maximize their efficiency when preparing for this examination.

List of abbreviations

Medical College Admissions Test (MCAT), United States Medical Licensing Exam (USMLE), grade point average (GPA), American Association of Medical Colleges (AAMC), Internal Review Board (IRB).

Declarations

Consent to participate: Not applicable.

Consent to publish: Not applicable.

Ethics approval and consent to participate

This study was reviewed and approved by the Saint Louis University International Review Board (IRB) and granted category 1 exempt status on 10/07/2024. The need for informed consent for participation was waived by the IRB in their review process. This study was not a clinical trial and thus does not have registration details. Our study was conducted in adherence to the Declaration of Helsinki.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing Interests

The authors declare that they have no competing interests.

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Author Contributions

A.R. and C.M. developed the concept and design of the study. Additionally, all authors made significant contributions to the acquisition, analysis, and interpretation of the data. A.R., O.M.P., N.S., and C.M. wrote the main manuscript text. All authors reviewed the manuscript.

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Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- MCATAnkiSurveyPDF.pdf