

Spaced Education With ABSITE Quest Resulting in Improved American Board of Surgery In-Training Examination Performance

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OBJECTIVE: The American Board of Surgery In-Training Examination (ABSITE) is an annual exam taken by general surgery residents as a cognitive assessment of the knowledge gained throughout each year of training. Several question banks are available for ABSITE preparation. However, ABSITE Quest (AQ) utilizes a method called spaced education which has been demonstrated to help with retaining information longer and improve exam performance. This study hypothesizes that using this method will help residents improve their ABSITE performance.

DESIGN: Retrospective survey data was collected from residents who participated in AQ, including postgraduate year (PGY) level, as well as 2019 and 2020 ABSITE percentiles. AQ user data was used to match respondent's total number of questions completed and daily engagement level to the survey data. Paired, single-tailed student's *t* test was used to evaluate the significance of ABSITE percentile change between 2019 and 2020 among AQ users.

SETTING: ChristianaCare, Newark, DE, United States. Nonclinical.

PARTICIPANTS: All ABSITE Quest users were surveyed ($n = 390$), of which 104 responded. 21 responses were from PGY1 residents and were excluded, resulting in a total of 83 responses.

RESULTS: The mean percentile difference of AQ users from 2019 to 2020 was +15.8 ($p < 0.00001$). When categorizing by the total number of questions completed, high

users demonstrated a mean percentile difference of +15.3 ($p = 0.00002$), average users had a difference of +19.1 ($p = 0.00029$), and low users showed a percentile difference of +1.2 ($p = 0.45244$). When categorizing by daily engagement level, high users demonstrated a mean percentile difference of +17.9 ($p < 0.00001$), low users had a mean percentile difference of +15.3 ($p = 0.00124$), and minimal users showed a mean percentile change of -5.7 .

CONCLUSIONS: The use of the spaced education method with ABSITE Quest, especially in users with a greater number of questions completed and high levels of daily engagement, correlated with a significant improvement on ABSITE performance. (J Surg Ed 000:1–7. © 2020 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: ABSITE, spaced education, microlearning, gamification, question bank

COMPETENCIES: Medical Knowledge

INTRODUCTION

The American Board of Surgery In-Training Examination (ABSITE) is an annual exam taken by all Accreditation Council for Graduate Medical Education general surgery residents as a cognitive assessment of the knowledge gained throughout each year of surgical residency training.¹⁻⁵ In addition to being used in that regard for the last 45 years, it has also been demonstrated to play a role in resident promotion, remediation, and American Board of Surgery (ABS) Qualifying Exam (QE) first time pass rate, which is important for residency program accreditation.^{5,6} While the ABSITE was not designed to be a factor used in the surgical fellowship selection process, most

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fellowship program directors rank ABSITE performance third only after recommendation letters and candidate residency program when evaluating fellowship applications.¹ It has also been shown to predict success for preliminary surgery residents in terms of matching into the categorical residency of their choice.⁷

Numerous studies have investigated the factors that affect ABSITE performance, resulting in residency programs implementing tools to aid their residents. Several interventions which have been shown to result in increased ABSITE scores include educational conferences,⁸ in-house practice tests,^{4,6,9} weekly readings tracked through quizzes and assignments,^{6,10} and practice questions.^{2,11,12} Furthermore, other factors have been shown to have a negative impact on ABSITE performance, such as burn out¹³ and absence of a remediation process.¹⁰

Due to the positive learning effects of retrieval practice, the use of practice questions has become an important way to prepare for any exam. Question banks, along with their impact on ABSITE performance, have been the subject of multiple studies.^{2,11,12} Nationwide, almost all general surgery programs subscribe to the Surgical Council on Resident Education curriculum¹¹ which includes self-assessment practice questions as part of its ABSITE preparation. In addition, many residents individually or institutionally choose to subscribe to one of the several commercially available questions banks.

ABSITE Quest (AQ) is a new learning platform designed to improve the study efficiency and knowledge retention of surgical residents. In an innovative and more scientific approach to question bank learning, AQ utilizes spaced education, retrieval practice, interleaving, and scheduled repetition. By utilizing interval reinforcement of information, the spaced education of ABSITE Quest attempts to mitigate the forgetting curve and significantly improve retention of knowledge. The theory behind this is that learning over time enhances memory and strengthens these new neuronal connections with planned repetition. The repeated process of information uptake over time builds efficiency in encoding the information so that it is preferentially retained and more easily recalled later. Spaced education has been shown to improve the process of studying¹⁴⁻²¹ by allowing for the learning of information over shorter intervals of time and then more successfully retrieving that retained knowledge in the format of an exam.²²

In addition to spaced education, AQ incorporates gamification and microlearning within its learning platform, both of which are methods that have been shown to increase engagement and improve the learning process.^{19-21,23-28} AQ is powered by Qstream, a mobile microlearning application designed to drive learner engagement and sustain learning across various different programs.

This study hypothesizes that surgical residents using AQ's spaced learning methodology of review questions would demonstrate improved ABSITE performance.

MATERIALS AND METHODS

AQ is a question bank focused on surgical residents preparing for the ABSITE. AQ utilizes the Qstream platform to deliver subscribers 3 questions per day, with correct questions being repeated in 21 days and incorrect questions repeated in 8 days. Questions are retired after being answered correctly twice. A point system is used to gamify the question bank, and a monthly competition is held amongst all subscribers. AQ was founded in May 2019 and was first available to residents prior to the 2020 ABSITE.

Data collection was performed via survey responses of AQ users following the 2020 ABSITE. The survey consisted of demographic data, including name and current postgraduate year (PGY) class, as well as his or her 2019 and 2020 ABSITE percentiles. Exclusion criteria included PGY1 class, as there was no 2019 ABSITE percentiles for this group, and lack of a survey response.

AQ user data was then matched to the responders, including the number of total questions completed and daily engagement level.

The total number of questions completed represented the total number of questions attempted, including those which were repeated. These were then divided into 3 categories consisting of high-, average-, and low question attempts. High was defined as greater than 300 questions attempted. Average was defined as 100 to 300 questions attempted. Low was defined as less than 100 questions attempted.

Daily engagement level represents the percentage of days questions were attempted since an individual subscription was initiated. This was calculated by dividing the user's total number of questions completed by 3, then dividing that value by the length of the subscription. Engagement level was then divided into 3 categories consisting of high, low, and minimal. High was defined as attempting questions on greater than 75% of days. Low was defined as attempting questions from 25% to 75% of days. Minimal was defined as attempting questions less than 25% of days.

Dependent (paired), single-tailed student's *t* test was used to evaluate the significance of ABSITE percentile change between 2019 and 2020 among AQ users. Additional statistics were performed after dividing the study population into cohorts based on daily engagement level, number of questions completed, and PGY class. A *p* value of <0.05 was chosen for statistical significance.

TABLE 1. Demographics

Total Responses	104
Total questions completed	
Mean (Median) total questions answered	340.2 (355)
Groups	
High	48
Average	30
Low	5
Daily engagement level	
Mean (Median) engagement level	73.6% (77.9%)
Groups	
High	50
Low	29
Minimal	4
Postgraduate year (PGY)	
PGY 1	21
PGY 2	16
PGY 3	17
PGY 4	19
PGY 5	10
Research	21

PGY, Postgraduate year.

RESULTS

Following the 2020 ABSITE, all AQ users (n = 390) were contacted, of which 104 responded (response rate = 26.7%). Of the responses, 21 were from PGY1 residents and thus were not included in the analyses, resulting in a total of 83 responses being included in the study. Additional demographic data can be seen in [Table 1](#).

The mean 2019 ABSITE percentile for all responders was 50.1 (standard deviation [SD] 26.6). The mean 2020 percentile for all responders was 65.9 (SD 23.9). The mean percentile difference from 2019 to 2020 was +15.8, with a p value of <0.00001 (see [Table 2](#)).

When the study population is categorized by the total number of questions completed, there were 48 high, 30 average, and 5 low users. The mean number of questions completed of all users was 340.2 (median 355). The mean ABSITE percentile among the high users was 54.8 (SD 27.6) in 2019 and 70.2 (SD 21.8) in 2020, with a mean percentile difference of +15.3 (p = 0.00002). The mean ABSITE percentile among the average users was

43.1 (SD 24.7) in 2019 and 62.2 (SD 25.4) in 2020, with a mean percentile difference of +19.1 (p = 0.00029). The mean ABSITE percentile among the low users was 47.4 (SD 18.9) in 2019 and 48.6 (SD 27.5) in 2020, with a mean percentile difference of +1.2 (p = 0.45244; see [Table 3](#)).

When the study population is categorized by the daily engagement level, there were 50 high, 29 low, and 4 minimal users. The mean daily engagement level of all users was 73.6% (median 77.9%). The mean ABSITE percentile among the high users was 51.4 (SD 26.8) in 2019 and 69.3 (SD 22.2) in 2020, with a mean percentile difference of +17.9 (p < 0.00001). The mean ABSITE percentile among the low users was 48.2 (SD 27.2) in 2019 and 63.6 (SD 25.0) in 2020, with a mean percentile difference of +15.3 (p = 0.00124). The mean ABSITE percentile among the minimal users was 47.5 (SD 24.4) in 2019 and 41.8 (SD 26.4) in 2020, with a mean percentile change of -5.7, see [Table 4](#).

Statistics were also run for each PGY class. These demonstrated improvement in ABSITE percentile after implementation of AQ in each class, with all except PGY5 being statistically significant. These data are demonstrated in [Table 2](#). [Table 5](#) demonstrates the utilization of ABSITE Quest based on daily engagement and total questions answered based on PGY class.

DISCUSSION

The ABSITE is taken annually by all Accreditation Council for Graduate Medical Education general surgery residents to assess their cognitive skills, critical thinking, and surgical knowledge. Its importance has grown over its 45-year history, and it has been shown to affect many aspects of the residents' current and future careers, including ABS-QE first time pass rate and fellowship placement. With an exam of such importance, it became increasingly important for surgery residents and programs to understand what factors influence performance on the ABSITE.^{2-4,6,8-13,29,30} While many preresidency factors have been shown to significantly influence

TABLE 2. Mean Percentile of 2019 and 2020 ABSITE—Overall and Postgraduate Year

	2019 ABSITE	2020 ABSITE	Difference	p Value
Overall	50.1 (SD 26.6)	65.9 (SD 23.9)	(+)15.8	<0.00001
PGY 2	45.4 (SD 25.5)	59.1 (SD 25.1)	(+)13.7	0.01684
PGY 3	42.8 (SD 19.9)	53.6 (SD 23.8)	(+)10.8	0.03002
PGY 4	53.6 (SD 24.5)	72.7 (SD 20.1)	(+)19.2	0.00053
PGY 5	50.8 (SD 34.1)	72.2 (SD 27.9)	(+)21.4	0.10892
Research	56.2 (SD 30.2)	72.1 (SD 20.8)	(+)15.9	0.0121

ABSITE, American Board of Surgery In-Training Examination; PGY, Postgraduate year; SD, standard deviation. PGY 1 residents excluded from statistical tests.

TABLE 3. Mean Percentile of 2019 and 2020 ABSITE—Total Number of Questions Answered

	n	2019 ABSITE	2020 ABSITE	Difference	p Value
High	48	54.8 (SD 27.6)	70.2 (SD 21.8)	(+)15.3	0.00002
Average	30	43.1 (SD 24.7)	62.2 (SD 25.4)	(+)19.1	0.00029
Low	5	47.4 (SD 18.9)	48.6 (SD 27.5)	(+1.2)	0.45244

ABSITE, American Board of Surgery In-Training Examination; SD, standard deviation.

TABLE 4. Mean Percentile of 2019 and 2020 ABSITE—Daily Engagement Level

	n	2019 ABSITE	2020 ABSITE	Difference	p Value
High	50	51.4 (SD 26.8)	69.3 (SD 22.2)	(+)17.9	<0.00001
Low	29	48.2 (SD 27.2)	63.6 (SD 25.0)	(+)15.3	0.00124
Minimal	4	47.5 (SD 24.4)	41.8 (SD 26.4)	(-)5.7	*

ABSITE, American Board of Surgery In-Training Examination; SD, standard deviation.

* Statistical analysis was unable to be performed for the Minimal group due to too few values.

TABLE 5. ABSITE Quest Utilization by Postgraduate Year

	PGY1	PGY2	PGY3	PGY4	PGY5	Research
Total	21	16	17	19	10	21
Daily engagement						
High	12	12	8	12	5	13
Low	7	3	9	7	3	7
Minimal	2	1	0	0	2	1
Total questions answered						
High	15	8	10	10	6	14
Average	4	7	7	9	2	5
Low	2	1	0	0	2	2

ABSITE performance such as USMLE Step 1 and Step 2 scores, as well as MCAT performance,^{3,4,29,30} preparation for ABSITE has been the main focus of numerous studies. de Virgilio et al.⁶ demonstrated that weekly reading assignments followed by weekly examinations increased the ABSITE scores an average of 19 percentile points. Other studies have focused on the use of questions banks.^{2,11,12} Flentje et al.² showed that the ABSITE percentile improved by 3 percentile points for every 100 practice questions completed. Imran et al.¹¹ demonstrated a correlation between the number of practice questions answered and the percentage of correct questions and percentile score on ABSITE.

Currently, there are several commercially available questions banks available to surgical residents and residency programs. These are largely conventional questions banks, where a subscription is purchased for a defined period of time and a set of questions with explanations is made available to the subscriber to be completed at his or her own pace. As compared to conventional questions banks, AQ was designed and founded based on the scientific principles of spaced learning, retrieval practice, interleaving, and gamification. The implementation of such

relatively new teaching techniques and their effect on ABSITE performance was the subject of our study.

With the evolution of newer teaching methods in the last few decades, medical education has not been far from the application of such methods. Spaced education involves learning information over shorter intervals of time as compared to learning larger portions at once. It does so by using 2 principles: the spacing effect, which increases knowledge retention by presenting information and reinforcing it over spaced intervals of time, and retrieval practice, which is an active learning process that also leads to knowledge retention.^{14-16,22}

Spaced education has been studied intensively in the field of medicine. Dr. Price Kerfoot, the surgeon who helped coin the term “spaced education” demonstrated through multiple studies that it is a very effective way of boosting learning efficiency¹⁴ and enabling long term retention of knowledge.^{15,16} Philips et al.¹⁷ showed that spaced education was one of the best methods for continuing professional development for healthcare professionals. It led to significant changes in clinician behavior, increase in clinician confidence, sustained increase in clinical skills, and improved patient outcomes. Additionally, Gyroki et al.¹⁸

showed that it leads to increased knowledge retention and better performance on exams. Beyond learning and knowledge retention, spaced education has also been shown as an effective tool for improving enthusiasm for teaching and teaching effectiveness.³¹

The theory behind gaining knowledge in small units of information is not new. This process, recently coined microlearning, refers to small lesson modules and short-term activities intended to teach and reinforce course objectives.^{24,25} The use of microlearning in healthcare predates the term “microlearning” itself. Many studies have demonstrated that microlearning improves performance and safety outcomes.^{26,27} DeGagne et al.²⁸ demonstrated that using microlearning among students in healthcare professions had a positive effect on their knowledge and confidence in performing procedures, retaining knowledge, studying, and engaging in collaborative learning.

Since life during a general surgery residency can get overwhelmingly busy, allocating time to prepare for examinations can prove to be challenging. Motivational techniques such as gamification can be beneficial since it has shown to increase engagement.^{19-21,23} Kerfoot et al. showed that combining spaced education with a game format can be an effective way of teaching core content and assess knowledge among medical students¹⁹ and residents,²⁰ as well as a well-accepted method to improve guideline knowledge among practicing physicians.²¹

So far, there has been no data published on the use of spaced education methods and their effect on ABSITE performance. Our data shows that using spaced education, microlearning, and gamification in the AQ question bank has been able to significantly improve ABSITE scores. However, it also puts further emphasis that high engagement is needed in order for these methods to make a difference, as evidenced by the difference in percentile change between the high and minimal engagement cohorts. In addition to the efficacy showed by these methods, time efficiency was well demonstrated. Since AQ sends only 3 daily questions to residents, it requires on average less than 5 minutes every day to complete.

To our knowledge, the current study has the largest number of participating residents compared to any other study involving the effect of review questions on ABSITE performance. Despite this, the limited number of responses is a limitation of the study. Additional limitations include utilizing a survey for data collection, as this can result in a response bias. As the distribution of survey respondents was skewed toward high and moderate user engagement groups, this also raises concern for potential response bias. This would be better evaluated with a study design that collects all users' data to eliminate this bias. Additionally, as there was no way to verify the self-reported scores, there is concern for a recall

bias. Future prospects may include tracking residents' performance while using AQ and correlating that with sustained improving ABSITE performance as well as ABSITE first time pass rate. Additionally, increasing the response yield by collaborating with entire programs who subscribe to AQ for their residents will help to eliminate limited survey responses and the associated response bias.

As Dua et al.³² showed that an integrated learning system approach correlates with an improved ABSITE score, it may be beneficial to incorporate AQ into an integrated learning system that continues to apply concepts of spaced education, microlearning and gamification, and assess its effect on resident performance in terms of examination and fellowship placement.

CONCLUSIONS

Using the spaced education methodology and other scientific learning principles, such as retrieval practice and gamification, ABSITE Quest did significantly improve ABSITE performance for residents engaged with the learning platform. Higher daily engagement with AQ's microlearning correlated with significant increases in ABSITE percentile score. The benefits of spaced education and microlearning go beyond exam scores, however. Survey respondents also noted time efficiency, since less than 5 minutes per day were required to complete AQ's 3 daily review questions. In the setting of the lifestyle of a busy surgical resident, the efficiency and mobile delivery of spaced education by AQ provides potential time saving value that cannot be understated. Furthermore, the daily routine of answering questions may help to build healthy study habits, which may also help to improve mental health and wellness of surgical residents who feel the stress of cramming for the ABSITE year after year.

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DECLARATION OF COMPETING INTEREST

Jason Weinberger - ABSITE Quest, chief executive officer and founder.

Benjamin L. Gough - ABSITE Quest, chief content officer and co-founder.

Michael Gerges - no known competing financial interests or personal relationships to declare.

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