QUALITATIVE RESEARCH ARTICLE

A Mixed-Methods Exploration of the Effect of Disabling Backward Navigation on Calculations Computerized Exams

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Objective. The aim of this mixed-methods study was to examine the effect of disabled backward navigation on computerized calculation exams in multiple courses.

Methods. Student performance on comprehensive pharmacy calculation exams before and after implementation of disabled backward navigation were compared. De-identified data from Examsoft were used to determine median exam scores, passing rates, and time to completion for all three attempts given on comprehensive calculation exams held in PharDSci 504 and the Applied Patient Care labs (Pharm 531, 541, and 551). An anonymous, voluntary student survey gathered student perceptions of disabled backward navigation. Qualitative data were evaluated for thematic findings.

Results. The impact of disabled backward navigation on test score and passing rate varied by course and test attempt. Students in Pharm 541 and 551 performed significantly worse on the initial test attempt once backward navigation was disabled compared to the prior year, with no significant differences in performance on the retakes. Performance in PharDSci 504 and Pharm 531 followed the opposite pattern with no significant difference in performance for the initial test but significantly increased performance on the retake. The amount of time spent on exams either significantly decreased or remained the same. Student perceptions were generally consistent across all cohorts with at least 74% agreeing that disabling backward navigation increased exam difficulty.

Conclusion. Disabling backward navigation had mixed effect on student exam performance. This may highlight how student behaviors change as backwards navigation is disabled.

Keywords: computerized exams; backward navigation; mixed-methods; pharmaceutical calculations, academic integrity

INTRODUCTION

Computer-based examinations are now commonplace throughout Doctor of Pharmacy (PharmD) programs. Although computer-based testing has been rapidly adopted in the last decade, many PharmD programs still face questions on best practices for using available features that balance test security while helping to minimize test anxiety for students. Of the many computer-based testing features available, disabled backward navigation is one of the most contested. When an instructor disables backward navigation, students are given only one opportunity to answer a question before moving on to the next assessment item. Alternatively, instructors can choose to allow backward navigation, which allows students to skip a question and then return to that question later in the exam like paper-based exams.

When Washington State University College of Pharmacy and Pharmaceutical Sciences (WSU CPPS) adopted computer-based testing using Examsoft in 2013, the college elected to allow backward navigation to previously viewed question items. In the years following adoption of computer-based testing, exam integrity concerns were raised by faculty and students. There were growing concerns over academic dishonesty on examinations related to syncing testing questions between students that sat near each other during proctored exams. These academic integrity concerns were occurring despite nearly universal adoption of test question and answer option randomization. In addition, faculty wanted to promote better study habits and test taking skills that would prepare the students for their North American Pharmacist Licensure Examination (NAPLEX) and Multistate Pharmacy Jurisprudence Examination (MPJE) which prohibit backward navigation. After thorough discussion by a committee consisting of faculty and students, WSU CPPS faculty voted to change the testing policy to disable backward navigation on all exams beginning the 2018-2019 academic year. To prevent accidental movement to the next question, all exams also required students to select/input an answer to each question before moving on. This change was implemented college-wide in every course. While the primary goal was to

improve academic dishonesty issues during testing, there was some concern from faculty and students that this feature would make examinations more difficult and increase testing anxiety.

Prior to starting this study, limited information was available in the literature about how the ability to freely navigate on a computerized test can impact test performance within higher education. Since initiation of these research efforts, two studies have been published that have investigated the effect of disabling backward navigation on pharmacy student examination performance. These studies looked at different courses, but identical sets of questions asked between years with and without backward navigation. Neither study found a significant impact on exam results.^{1,2} A third study recently published collected student perceptions related to the implementation of computer-based testing at their institution. The authors report that 62% of surveyed pharmacy students believed that the ability to navigate to previous questions either significantly improved or slightly improved their performance on exams.³ Outside of the pharmacy education literature, Elsalem et al. investigated the stress levels of undergraduate medical students during remote electronic exams during the COVID-19 pandemic versus previous in-person exams. Students who reported a greater level of stress with remote electronic exams reported that the mode of question navigation was a main factor of their stress along with exam duration and technical problems.⁴

Herein, we describe a study to determine the impact college-wide implementation of disabled backward navigation had on pharmacy students in their first, second, and third professional years. To assess the impact on student exam performance, we retrospectively compared comprehensive pharmacy calculation exam scores between years where backward navigation was enabled versus disabled. Our study focused on comprehensive pharmacy calculation exams as these are consistently given each semester to ensure students understand calculation concepts. Because our PharmD program is competency-based and allows multiple attempts to show competency, we also compared how the testing change impacted student performance on each of the three testing attempts allowed. We further compared the length of time students spent completing the exams before and after the testing policy change. In addition to investigating exam performance measures, we collected student perceptions of the college-wide switch to disabled backward navigation and present both quantitative and qualitative survey findings.

METHODS

A mixed-methods approach was used to examine the impact of disabled backward navigation on student performance. Calculation examination scores from four courses throughout the curriculum were included in this analysis. An additional Applied Patient Care (APC) course (Pharmacy 561) also includes a comprehensive calculations assessment, but it was not included in the analysis due to major changes in the course and instructor between the years of comparison. The courses included in this research are displayed in Table 1. Additionally, student perceptions of the change to disabled backward navigation were gathered. The WSU Office of Research Assurances has found that the project is exempt from the need for IRB review.

PharmD program overview

WSU CPPS offers a unique active learning curricular approach where introductory materials are provided to students as pre-class content (short video, readings, worksheets, etc.) with the in-class time dedicated to collaborative exercises facilitated by faculty. In addition to an active learning curricular delivery model, WSU CPPS uses a 3-tiered grading scheme of Honors, Satisfactory, and Failure (H-S-F). Important aspects of the model include frequent testing, testing over smaller amounts of material, and multiple attempts to meet competency.⁵ The competency-based assessment model requires students achieve at least 80% on each assessment with some assessments, including calculation comprehensive exams, having a more stringent competency bar of 90%. This higher competency bar for calculation-focused comprehensive exams emphasizes that accurate completion of calculations is critical as pharmacist. Students that fail to demonstrate competency on the first attempt of an assessment, have two additional opportunities to remediate. Those three attempts are the initial test, retake, and Extended Learning Experience (ELE). If students fail to show competency after three attempts on an assessment, they fail the course. The questions on each assessment are unique but maintain similar difficulty.

Course descriptions

Pharmacy calculations (PharDSci 504) provides first-year student pharmacists with the opportunity to learn essential pharmacy calculations within their first semester. Students are given three attempts to demonstrate competency on three quizzes (80% competency required) and a final comprehensive exam (90% competency required).

After completing the Pharmacy Calculations course, students are required to maintain and demonstrate calculations topic skills throughout the curriculum in the APC Laboratory course series. Each of the APC laboratory courses offers multiple opportunities to practice calculation skills during the semester culminating in a comprehensive

calculation examination at the end of the semester. Student pharmacists must demonstrate competency on this examination by achieving a minimum score of 90%. Students have three opportunities to reach this competency threshold.

Student performance

All students enrolled in one of these noted courses during the 2017-2018 academic year when backward navigation was enabled and the 2018-2019 academic year when backward was disabled were included in this analysis. Assessment questions were not identical between academic years. Instead, questions were designed to be similar in difficulty, as assessed by Bloom's taxonomy coding, and to assess the same learning objectives. Student performance on each exam attempt was downloaded from Examsoft, and inputted into a Microsoft Excel file, with all student identifiers including name and student ID number removed. Similarly, reports of the total time taken on each exam attempt were downloaded from Examsoft and deidentified.

Description of the survey

First-, second-, and third-year student pharmacists in the program were offered the opportunity to participate in an online survey using Qualtrics (Qualtrics, Provo, UT) through an anonymous link sent to them via email. The survey was optional, and students had the opportunity to opt-out if they decided. This survey was administered at the beginning of spring 2019 semester, following the first semester in which backward navigation was disabled on exams. The goal of the survey was to determine the student perceptions of how disabling backward navigation has affected them on exams. The surveys for second- and third-year students included 15 questions comprised of two questions about campus and professional year, nine Likert-scale questions, and four free response questions. As the first-year pharmacy students had no prior experience with enabled backward navigation, the survey for this cohort only included eight questions (two questions about campus and professional year and six Likert-scale questions).

Data analysis

All data and statistical analysis was completed using either Microsoft Excel or Graphpad Prism 6 (Graphpad Software, Inc., La Jolla, CA). The D'Agostino-Pearson normality test was used to determine the normality of data. Results of the normality tests indicated the vast majority of the data was not normally distributed; as a result, non-parametric statistical tests were used throughout. Mann-Whitney U tests were utilized when comparing test scores between academic years and when assessing differences in length of time spent on exams. Fisher's exact test was used to compare statistical differences in passing rates. Differences in perceptions by professional year from the student surveys were compared through the Kruskal-Wallis test followed by Dunn's post hoc test for multiple comparisons. The Mann Whitney U test was used to determine if there was statistical difference between cohorts for questions asked only to the PY2 and PY3 students.

Data from the free response survey questions was exported into Microsoft Excel and coded to identify themes.⁶ First-level coding (identifying text that is meaningful and recurrent) was performed by two researchers. The researchers coded the first question together using inductive coding methods and the remaining questions independently. The results of the first-level coding were compared and discussed to develop a codebook, which was stored in Excel and continuously modified as needed to improve the code names and organization. Second-level coding (grouping codes into meaning units and organizing the units into larger thematic areas) was performed by the two researchers together to determine themes. Disagreements were reconciled via discussion.

RESULTS

Student test scores and passing rates on comprehensive calculation exams administered in different courses throughout the professional program are noted in Table 2. As our program is competency-based, students needed to score a 90% or better on each calculation exam in order to pass the assessment. ELE data (third attempt) from only one class is shown due to the low numbers of students completing an ELE test in other courses.

The impact of disabled backward navigation varied by course. In the first-year pharmacy calculations course (504) and the second-year Fall APC lab course (531), student performance was not affected by disabled backward navigation on the initial attempt or the ELE attempt. Interestingly, students in the first-year calculations course and second-year Fall APC courses performed significantly better when backward navigation was disabled on the retakes ($p < .05$ and $< .01$ for first-year calculations and second-year Fall APC, respectively). Students with disabled backward navigation on the initial tests in the second-year Spring and third-year Fall APC lab courses (541 and 551) performed significantly worse than the prior year when backward navigation was allowed ($p < .01$ and $< .05$, respectively). However, there were no significant differences in performance on the retakes for these courses.

The duration of time students spent on their cumulative calculation exams when backward navigation was enabled, and disabled is reported in Table 3. The amount of time spent on exams either significantly decreased or had no change following the disabling of backward navigation.

Quantitative results of student perceptions collected through the administered survey are presented in Table 4. The response rates to the survey were 50% (84/168) for PY1s, 99% (168/169) for PY2s, and 91% (148/162) for PY3s. The higher response rates for the PY2 and PY3 students likely is the result of their cohort involvement in providing input on the testing policy change. As the PY1 students were new to program and likely had no previous experience in pharmacy school with enabled backward navigation, they were less vocal about the change. Perceptions were generally consistent between the three professional years even though the PY1 students had no past experience with enabled navigation within pharmacy curricula. Students perceived that disabled backward navigation increased exam difficulty with 74% of PY1s, 79% of PY2s, and 80% of the PY3s strongly agreeing, agreeing, or somewhat agreeing with the statement, "The lack of backward navigation has made exams difficult." When it came to the benefits of the testing change, 66% of students agreed that they see a benefit, but opinions were divided on if disabled backward navigation helped to decrease academic dishonesty (50% somewhat disagreeing, disagreeing, or strongly disagreeing). A greater number of PY1 students (52%) agreed or strongly agreed that having one attempt at a question helps to prepare them for the NAPLEX/MPJE in comparison to PY2s (33% agreed/strongly agreed; $p=.0019$). Fifty-eight percent of students strongly agreed, agreed, or somewhat agreed that they were motivated to perform well on initial exams now that backward navigation is disabled. Test anxiety was a major concern noted by the students with 84% of students reporting they strongly agreed, agreed, or somewhat agreed with the statement, "Having only one opportunity to answer a question before moving on, creates additional test anxiety for me." For the PY2 and PY3 students that could compare to the previous academic year, students reported that they spend more time on each question but not necessarily more time completing exams. Interestingly, 51% of PY3 students strongly agreed or agreed with the statement, "The amount of time I spend completing exams has increased with disabled backward navigation," versus 38% of PY2 students ($p<.01$).

To understand how the move to disabled backward navigation impacted the PY2 and PY3 students who had previous experience with enabled backward navigation, free responses questions were included on the PY2 and PY3 surveys. Student pharmacist responses to Question 12 (How do you feel about backward navigation being disabled?), Question 13 (How has disabled backward navigation changed your study habits?), and Question 14 (How has disabled backward navigation changed your test taking strategies?), are displayed in Table 5. Free response Question 15 (What are other ways the college could help prepare students for the NAPLEX?), was used as information purposes for the college and the purpose of improving student preparedness so these results were not included in this paper.

DISCUSSION

The decision to disable backward navigation on all exams college-wide required considerable efforts to gain student buy-in. In the semester prior to instituting the change, student thoughts and ideas were gathered about how to address academic dishonesty concerns, while also how to best prepare students for future licensure exams. A committee was created with students having an integral role. Having student input was pivotal in getting student buy-in with the removal of backward navigation. This did not completely alleviate student anxiety or pushback, however. As a result of these student concerns, a student and faculty group formed that led to the development of this study to evaluate student exam performance and perceptions following disabling backward navigation.

As shown in Table 2, the impact of disabled backward navigation on student performance varied by year in the program. No significant differences in initial test performance were seen for students earlier in the program (504 and 531 courses), while significant decreases in initial performance were seen for PY2 and PY3 APC courses (541 and 551). One possible explanation for this observed difference is related to engrained test taking strategies where the more senior students had at least one year of experience with being able to go back and review questions before submitting the exam. The senior students, particularly the PY3 students, may have developed a test-taking routine when backward navigation was enabled that was disrupted by the test-policy change. Interestingly, the median test score for the 541 course was identical between years where backward navigation was enabled versus disabled, but the lower end of the interquartile range was much lower when backward navigation was disabled. This highlights the implementation of disabled backward navigation impacted the lower performing students more than higher performing students within the same cohort.

An opposite pattern emerged for students completing retakes. Students had significantly better performance on retakes in the 504 and 531 courses earlier in the program when backward navigation was disabled while no differences were seen for retake performance for the later 541 and 551 courses. This difference is possibly due to the perceived difference in the stakes of the exams as shown by the student perceptions of increased exam difficulty after disabling backward navigation (Table 4). The student perception of increased difficulty likely led to changes in student behavior related to studying for exams.

The mixed results of this study contrasts with recently published reports that provide evidence that eliminating backward navigation on exams does not significantly affect exam scores. A study by Caetano et al. showed no significant differences in overall item difficulty before and after disabling backward navigation. When comparing exam scores, they found a statistically significant decrease of 0.95% in exam scores for the highest performing students, however, the study did not demonstrate that disabling backward navigation had a significant impact on overall item performance or exam results.² Another study by Cochran et al. looked at six examinations which backwards navigation had been eliminated and showed no significant reduction in exam scores.¹ It is important to note that these studies are from programs that utilize a fundamentally different grading model, specifically a traditional A-F grading scheme, in comparison to our competency-based model. As the design of assessments vary between a traditional vs. competency-based programs, the results presented herein may only be generalizable to other competency-based programs.

The overall time needed for students to complete their exams (Table 3) was generally reduced despite students' perception that they spent longer on each exam question. This may be explained by the fact that disabling backward navigation stopped students from reviewing their exam again before submitting. Our results align with data reported by Cochran et al. that showed the average time that students spent on each question was significantly reduced on two of the six examinations.¹

When backward navigation was enabled, students freely navigated between questions on an exam. This allowed for potential academic dishonesty by letting students skip to the same question as their neighbor. Disabling of backward navigation along with question randomization greatly decreases the likelihood of being on the same question as a neighbor at the same time. Pinpointing the best way to address academic dishonesty can be difficult given how prevalent it may be among pharmacy students. One study assessed the prevalence of academic dishonesty in which 16.3% of students admitted to cheating during pharmacy school, and approximately 74% admitted they or their classmates worked on an individual assignment with a friend.⁷ One study looked to identify specific genders involved in cheating;⁸ it concluded that no gender-based differences were noted in cases of admitted cheating or academic dishonesty. This study identified that the female students surveyed reported witnessing cheating more than male students and the male students surveyed may have had a more lenient perception towards academically dishonest behavior.⁸ Another study by Monteiro et al. reviewed social networks involved in cheating, which concluded that medical students are involved in social networks of cheating, that increase over time and are more prevalent in the fifth year (17.3%), compared with the first year (3.4%).⁹ However, if educators continue to raise awareness of how testing modifications can be perceived by students, in order to foster a professional environment while simultaneously decreasing stress associated with pharmacy school, a positive shift in culture could potentiate.¹⁰

Limitations of this study include only one set of data collected at one institution, which only measured performance on comprehensive calculation exams with assessments that were not the same between years. Although the same learning objectives were assessed, it is possible that differences between the cohorts led to the differences seen on the exam scores. We did not attempt to stratify student performance by incoming GPA or performance in math-focused prerequisite courses. In addition, our use of historical controls could also be impacted by a multitude of other factors such as slight variations in teaching strategies and/or use of different student resources between years of data collection. It may also be possible that the number of students who had previous experience with backward navigation on computerized exams varied between compared cohorts. As our study focused solely on calculation assessments, it is also possible that math-based classes may be impacted differently by a backward navigation disablement than other course types within a PharmD program. This information may not be generalizable to other institutions because the competency-based-assessment model is inherently different from standard grading. Furthermore, our competency-based-assessment model provides students with three attempts to demonstrate competency while other competency-based programs have their own unique systems to remediate students. The number of attempts given to demonstrate competency likely impacts students' motivations as the stakes of the assessment increases. In addition, the student survey only assessed the opinions of students after backward navigation was disabled and not the opinion of students prior to the testing policy change. Other limitations related to the qualitative data analysis include researcher's personal biases, and the volume of data associated with the study.¹¹

CONCLUSION

The impact of disabled backward navigation was evaluated in four courses each assessing calculations through a comprehensive exam. When backward navigation was disabled on initial attempts, students performed statistically worse in two of the four classes evaluated. However, when backward navigation was disabled on assessment retakes, students performed statistically better in two of the four classes. This may highlight how student behaviors may change as the stakes for an assessment increase. The time students took completing an assessment either stayed the same or decreased significantly when backward navigation was disabled depending on the specific course and assessment attempt. Student

perceptions of the change disabling backward navigation were negative in all professional years. Although most students believed their study habits did not change, almost all students (90%) noted changes with their test taking strategy, specifically reading questions more carefully and no longer second-guessing their answers.

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Table 1. WSU CPPS courses with assessments of calculation competencies included in analysis.

Course name	Course number	Location in curriculum	Calculations content	Competency required
Pharmacy Calculations	PharDSci 504	Fall PY1	Prescription order interpretation Calculation of concentrations, dosages, administration rates Creatinine clearance Compounding calculations	90% (18 out of 20) on end of semester examination
Applied Patient Care 2	Pharmacy 531	Fall PY2	Weight-based dosing Insulin dosing Creatinine clearance Days supply	90% (9 out of 10) on end of semester examination
Applied Patient Care 3	Pharmacy 541	Spring PY2	Heparin dosing Days supply	90% (9 out of 10) on end of semester examination
Applied Patient Care 4	Pharmacy 551	Fall PY3	Opioid conversions	90% (9 out of 10) on end of semester examination

PY=professional year

Table 2. Cumulative calculation test scores and passing rates during the academic year when backward navigation was enabled (2017-2018) versus when backward navigation was disabled (2018-2019). Scores are stratified by course and each testing attempt offered.

Test attempt	Course	Prof. year	Total students		Median test score (IQR)		<i>p</i> value ^a	Passing rate (%)		
			Enabled backward navigation	Disabled backward navigation	Enabled backward navigation	Disabled backward navigation		Enabled	Disabled	<i>p</i> value ^b
Initial test	504	PY1	155	157	90 (75-95)	90 (80-95)	NS	55	59	NS
	531	PY2	162	169	90 (80-100)	90 (90-100)	NS	74	78	NS
	541	PY2	164	168	100 (90-100)	100 (80-100)	<.01	88	70	<.001
	551	PY3	148	161	93.8 (87.5-100)	88.9 (80.6-100)	<.05	64	44	<.001
Retake	504	PY1	67	64	85 (80-95)	90 (81.3-95)	<.05	46	64	NS
	531	PY2	34	33	90 (87.5-90)	100 (90-100)	<.01	76	85	NS
	541	PY2	15	44	100 (90-100)	100 (90-100)	NS	93	86	NS
	551	PY3	54	18	90.6 (79.7-100)	90 (80-100)	NS	50	72	NS
ELE	504	PY1	37	23	95 (90-97.5)	95 (90-100)	NS	92	78	NS

IQR=interquartile range; NS=not significant; PY1=first-year pharmacy student; PY2=second-year pharmacy student; PY3=third-year pharmacy student.

^aStatistical differences between test scores assessed via Mann-Whitney U test.

^bStatistical differences between passing rates were assessed via Fisher's exact test.

Table 3. Length of time in minutes spent on cumulative calculation exams when backward navigation was enabled and disabled. Scores are stratified by course and each testing attempt offered.

Test attempt	Course	Prof. year	Allowed time (min)	Median (IQR)		p value ^a
				Backward navigation enabled	Backward navigation disabled	
Initial test	504	PY1	120	82 (69.5-99.5)	81 (69-103)	NS
	531	PY2	60	41 (34-49)	27 (23-33)	<.001
	541	PY2	60	29.5 (24-34)	27 (23-32.75)	NS
	551	PY3	60	56 (49-60)	52 (47-57)	<.001
Retake	504	PY1	120	107 (80-117)	84.5 (70-101.8)	<.001
	531	PY2	60	33 (26.5-39.25)	33 (23-37.5)	NS
	541	PY2	60	26 (16-47)	26 (20-33.5)	NS
	551	PY3	60	60 (54-61)	43 (31-49.25)	<.001
ELE	504	PY1	120	95 (83.5-110)	98 (74-112)	NS

IQR=interquartile range; NS=not significant; PY1=first-year pharmacy student; PY2=second-year pharmacy student; PY3=third-year pharmacy student.

^aStatistical differences between length of time spent on exams assessed via Mann-Whitney U test.

Table 4. Likert scale means of student perceptions divided by professional year.

Question number and wording		Median (IQR)			p value
		PY1 n=84	PY2 n=168	PY3 n=148	
Q1	The lack of backward navigation has made exams difficult.	3 (2-4)	2 (1-3)	3 (2-3)	NS ^a
Q2	Having only one opportunity to answer a question before moving on, creates additional test anxiety for me.	2 (1-3)	2 (1-3)	2 (1-3)	NS ^a
Q3	I see a benefit with disabling backward navigation on exams.	3 (2-4)	3 (2-5)	3 (2-4)	NS ^a
Q4	The lack of backward navigation on exams is helping to prepare me for the NAPLEX and MPJE.	2 (2-3)	3 (2-5)	3 (2-4)	<.01 ^a , .0019 ^b
Q5	Disabling backward navigation decreases academic dishonesty.	4 (3-5)	3 (3-5)	3 (2-5)	NS ^a
Q6	I am motivated to perform well on my initial exams now that backward navigation is disabled.	3 (2-4)	3 (2-5)	3 (2-5)	NS ^a
Q7	The amount of time I spend completing exams has increased with disabled backward navigation.	n/a	4 (2-5)	2 (1-4)	<.01 ^c
Q8	The amount of time I have to spend on each question has increased with disabled backward navigation.	n/a	2 (1-4)	2 (1-3)	NS ^c
Q9	The lack of backward navigation has decreased my performance on exams.	n/a	3.5 (2-5)	3 (2-4)	NS ^c

IQR=interquartile range; NS=not significant; PY1=first-year pharmacy student; PY2=second-year pharmacy student; PY3=third-year pharmacy student.

Responses were based on a six-point Likert scale: 1=strongly agree, 2=agree, 3=somewhat agree, 4=somewhat disagree, 5=disagree, 6=strongly disagree.

^aStatistical significance between PY1, PY2, and PY3 cohorts assessed using Kruskal-Wallis test.

^bPY1 significantly different from PY2 assessed by Dunn's multiple comparisons test.

^cStatistical significance between PY2 and PY3 cohorts assessed using Mann-Whitney U test.

Table 5. Themes and quotes for free response questions (12, 13, 14).

Student responses to Question 12, "How do you feel about backward navigation being disabled?" (n=130 PY2s and 139 PY3s)		
Theme	Opinion	Quotes
Students' beliefs about the impact of disabling backward navigation on their test-taking performance	Improved test-taking performance (n=18 PY2s, n=12 PY3s)	<ul style="list-style-type: none"> • "At first I was very upset that backward navigation was disabled, however now I almost prefer it and find myself doing better on exams." (PY2) • "It has helped me so far. My grades have improved, and I have less anxiety taking the test. I feel more confident in my answers now." (PY2) • "I think that it is more difficult, yet because of this it makes us have to be more prepared which I believe is a positive thing." (PY3) • "This feature eliminates the ability to do a final review of all exam questions as a double check to see if any questions were misunderstood." (PY2)
	Hindered test-taking performance (n=45 PY2s, n=33 PY3s)	<ul style="list-style-type: none"> • "Although I think it has made me more decisive when it comes to exams, I think that it overall has a negative impact on my exam performance." (PY3) • "It does not help me in terms of learning things, and it adds to us spending extra time on each question with limited time since our exam time was not extended." (PY3)
	Improved testing experience (n=10 PY2s, n=6 PY3s)	<ul style="list-style-type: none"> • "I actually don't mind it; I feel that I have performed better on exams, and I don't second-guess myself." (PY2) • "I spend more time on questions. I also don't end up changing my answers which most of the time doesn't help me." (PY2)
Students' beliefs about the impact of disabling backward navigation on their test-taking experience	Neutral or mixed feelings about experience (n=30 PY2s, n=45 PY3s)	<ul style="list-style-type: none"> • "I am mixed about it. For some exams, especially [Pharmacy Law] I would like to have backward because it is open book. But otherwise, I could care less about it." (PY2) • "It is both good and bad. It is good because I don't have to second guess myself and just move on, but I hate it because sometimes I want to skip a question and move on and come back without wasting my time." (PY2) • "I am largely indifferent. I spend the same amount of time, net, that I did before. I just spend more time on each question as opposed to jumping around." (PY2)
	Reduced testing anxiety (n=4 PY2s, n=3 PY3s)	<ul style="list-style-type: none"> • "I support backward navigation and think that it helps lessen my anxiety." (PY2) • "It greatly relieved some of my testing anxiety." (PY2)
	Increased testing anxiety (n=24 PY2s, n=23 PY3s)	<ul style="list-style-type: none"> • "I feel that it sends the message that double checking our work isn't necessary and has increased my anxiety during testing." (PY2) • "While I understand the intent to prepare for national exams, it causes undue stress on our block exams. It is incredibly easy to miss something when you can't go backward. I feel like it would be easier to expel students for academic dishonesty instead of trying to curtail the cheater's behavior." (PY2) • "It gives me extra anxiety and wastes more of my time than I would typically spend on one question." (PY3)
Students' beliefs about the impact of disabling backward navigation on NAPLEX preparation	Aids in preparing for the NAPLEX (n=3 PY2s, n=16 PY3s)	<ul style="list-style-type: none"> • "Actually, I think it's good that way because it prepares myself for the national exams and also force me to be more careful in reading the questions." (PY2) • "I think it is good in that it imitates what to expect on the NAPLEX and other professional exams. I think it is also a true testament to someone's knowledge rather than having backward exam." (PY3) • "It is good practice for the future board exams and has not affected my test taking as much as I expected." (PY3) • "Several students who have taken the NAPLEX have stated that the lack of backward navigation is the least of our worries when it comes to that exam." (PY2)
	Does not aid in preparing for the NAPLEX (n=5 PY2s, n=7 PY2s)	<ul style="list-style-type: none"> • "I don't think that this honest to say this is to prepare us for NAPLEX. If you were preparing us for NAPLEX then our exams would be more difficult, and case based like the NAPLEX." (PY3) • "Lack of backward navigation isn't helping my grades nor will help me prepare for the NAPLEX." (PY3)

Students' beliefs about the impact of disabling backward navigation on academic integrity	Not a reasonable justification (n=4 PY2s, n=5 PY3s)	<ul style="list-style-type: none"> • "It's frustrating. I don't see the benefit of having backward navigation disabled. We only have to take the NAPLEX once so why disable backward navigation on all of our exams." (PY2) • "I understand that it may have been put in place to resemble the NAPLEX exam, and the lack of backward navigation, but I also feel that I am still very much in the learning phase, and at a point that I need that chance to do a self-check." (PY3)
	Improved academic integrity (n=3 PY2s, n=5 PY2s)	<ul style="list-style-type: none"> • "I think it is a good way to prevent cheating and I don't think it prevents me from performing well." (PY2) • "I feel it is a good thing to reduce the ability of people to cheat." (PY3)
Students' beliefs about the impact of disabling backward navigation on academic integrity	Did not improve academic integrity (n=2 PY2s, n=5 PY3s)	<ul style="list-style-type: none"> • "People in our class who are not academically honest will always continue to find a way to cheat. I am sure they have found a way to cheat with backward navigation being disabled. People will always lack integrity." (PY2) • "I honestly do not think it resolves the cheating problem. People could switch laptops with others if they really wanted to cheat, where's the fix for that problem?" (PY3) • "I understand that it is to prepare us for board exams and discourage academic dishonesty. However, if people are going to cheat, they are going to cheat either way. They could just take a while on the exam and look at what others are putting for answers." (PY3)

Student responses to Question 13 "How has disabled backward navigation changed your study habits?" (n=125 PY2s and 131 PY3s)

Theme	Opinion	Illustrative Quote
Students' beliefs about disabling backward navigation on study habits	More time studying (n=12 PY2s, n=6 PY3s)	<ul style="list-style-type: none"> • "I have studied more broadly and taken my time on studying because I have taken my time reading and answering questions during exams." (PY2) • "It has made me study longer hours due to the reason that i get one chance to get answer correct." (PY2) • "It has required more time spent on focusing intensely on the work and study guides provided in class." (PY2) • "It has made me have to gain a deeper understanding of the material, specifically individual concepts. I feel like I need to know it better to be able to answer a specific question on exams and not be able to gain context or clarification from other answers." (PY3)
	More effort studying (n=12 PY2s, n=17 PY3s)	<ul style="list-style-type: none"> • "I have definitely put more thought and effort into my studying. That is a positive result of the change, and I've been able to improve my study habits." (PY2) • "I study harder. I make sure I am able to answer every objective so that when I see the potential exam question, I am confident enough to select it and not second guess my answer." (PY3)
Students' beliefs about disabling backward navigation on study habits	New strategies for studying (n=7 PY2s, n=7 PY3s)	<ul style="list-style-type: none"> • "I have to study every single detail so that I don't miss anything." (PY2) • "I have been slowly trying to modify my study habits, but it has been difficult to find a system that works very well." (PY3) • "It has made me have to gain a deeper understanding of the material, specifically individual concepts. I feel like I need to know it better to be able to answer a specific question on exams and not be able to gain context or clarification from other answers." (PY3) • "I don't feel that it has changed my study habits that much, as I still try to learn the information that is provided and crucial to know." (PY2)
	Study habits did not change (n=85 PY2s, n=95 PY3s)	<ul style="list-style-type: none"> • "My study habits are still the same except when I try to review for retakes, and I can't remember the questions or topics I did not do well on the exam." (PY3) • "It has not changed it all. My study habits have remained the same. I do the pre-work, I go to class, I do class-work and then I make study guides and review it." (PY3) • "It hasn't changed my study habits. I have studied equal amounts since backward navigation has been disabled and I am always equally motivated to pass the exams on my first try." (PY3)
Students' beliefs about disabling backward navigation on study habits	Studying is more stressful (n=10 PY2s,	<ul style="list-style-type: none"> • "If anything, it just makes it more stressful when I'm studying because I know that when I take the test, I won't be able to check my answers." (PY2) • "I am more stressed not about passing the exam without running out of time rather than the material." (PY3)

Answers to question 14 “How has disabled backward navigation changed your testing-taking strategies?” (n=130 PY2s and 131 PY3s)

Theme	Opinion	Illustrative Quote
Students’ beliefs about disabling backward navigation on test-taking strategies	Reading carefully (n=9 PY2s, n=17 PY3s)	<ul style="list-style-type: none"> • “Yes, I now spend more time now reading the questions knowing I can't go back. It also lowers my anxiety and improve my confidence in answering questions.” (PY2) • “Yes, completely. I am unable to move on from certain difficult questions and spent time analyzing and optimizing the answers to avoid getting the answers wrong.” (PY2)
	Slowing down (n=44 PY2s, n=50 PY3s)	<ul style="list-style-type: none"> • “It has forced me to slow down and take my time, where previously I would miss key information and therefore miss questions.” (PY2) • “It has made me slow down and read each question at least 3 times before moving on.” (PY3) • “I take things more slowly. I generally never need to change an answer, but once in a while, another question in the exam makes you realize an answer was wrong. For me this has been minimal, but it definitely has occurred.” (PY3)
	Rechecking answers (n=11 PY2s, n=5 PY3s)	<ul style="list-style-type: none"> • “Have to double check and triple check instead of going with my first instinct. Questioning my answers made me wrong half the time anyway.” (PY2) • “I recheck my answers 3-4 times before I move onto the next question. I cannot use previous answers to guide my thoughts when I get stuck on a question. You either know the answer or you don't with background navigation.” (PY2) • “I have to be more careful answering questions before moving on and must collect all my thoughts before submitting my question.” (PY3)
	Has not changed my test-taking strategies (n=16 PY2s, 14 PY3s)	<ul style="list-style-type: none"> • “My test taking strategies are ultimately the same as well. I simply spend more time than before on one question at a time in order to ensure that I am not making any mistakes before moving on.” (PY2) • “It hasn't much, I rarely look back after answering a question aside from the occasional answer being given in another question.” (PY2)