RESEARCH

Integration of a Community Pharmacy Simulation Program into a Therapeutics Course

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Objective. To demonstrate the feasibility of integrating the computer simulation, MyDispense, into a therapeutics course and to measure its effects on student perception and learning.

Methods. We conducted a prospective study with an experimental phase and an implementation phase. In the first phase, students were randomized to complete a therapeutics case using MyDispense or traditional paper methods in class. In the second phase, all students completed two therapeutic cases using MyDispense in class with the option to complete four additional outside-of-class cases using MyDispense. Students completed pre- and post-tests in class and three surveys.

Results. In the experimental phase, mean test scores increased from pre- to post-test for both MyDispense and traditional paper groups, but the difference between the groups was not statistically significant. Students in the traditional paper group reported statistically significant gains in confidence compared to the MyDispense group. In the implementation phase, mean test scores again increased, however, student perception of the use of MyDispense for therapeutics was negative. Completing the optional outside-of-class cases, however, was positively and significantly correlated with the midterm and final examination scores.

Conclusion. Implementation of MyDispense in therapeutics may be feasible and has positive effects (eg, correlation with exam scores, capacity for immediate feedback, and potential for effective self-study). With short-term use and in the absence of assessment methods that also require seeking information from patients, students prefer to learn via traditional paper cases.

Keywords: simulation training, education, pharmacy, pharmacies, curriculum

INTRODUCTION

The integration and application of knowledge to solve medication-related problems is a critical skill for pharmacists.[1] One easy approach to help pharmacy students practice this skill is case-based teaching which commonly uses patient cases prepared in paper format (and sometimes also projected on a screen).[2-6] However, unlike an authentic pharmacy practice experience, paper-based cases do not require students to gather and summarize all relevant patient-specific information on their own. Branched, or "choose your own adventure-style" cases in which students are supplied patient information in stages may be more realistic but can still provide too much information up front as compared to actual practice.[7]

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Computer simulation can help to overcome this limitation as they offer an environment where students can solve problems as they would in actual practice – by seeking information from the patient and/or the medical record in real time and responding accordingly.[8] An additional advantage of computer simulations, particularly for novice learners, is that they allow students to practice exercises multiple times without the risk of causing harm to a patient. Furthermore, they offer individualized learning opportunities and the potential for immediate feedback. This deliberate practice with immediate feedback can facilitate student development of skills and knowledge application to solve complex therapeutic problems. Finally, simulation can be used to integrate a curriculum, as more complex cases can incorporate concepts from multiple courses and disciplines.

MyDispense is an example of such a simulation program. This software, developed by the faculty of Pharmacy and Pharmaceutical Sciences at Monash University

in Melbourne, Australia, simulates community pharmacy practice. In MyDispense, the student functions as a pharmacist to evaluate, verify, and dispense a prescription as if the student were in an actual community pharmacy.[9] The program can provide an opportunity for repetitive and deliberate practice with immediate feedback. As of September 2016, it has been adopted by 18 pharmacy schools within the United States and 28 schools internationally to help students develop competency in community pharmacy practice. Since 2014, the University of California San Francisco (UCSF) School of Pharmacy has used MyDispense as a teaching and assessment tool in the curriculum, both in the classroom (primarily in a Law & Ethics course) and to satisfy up to 50 hours of introductory pharmacy practice experiences (IPPEs).

In pharmacy practice, solving a therapeutic problem requires critical evaluation and verification of a prescription based on relevant, patient-specific information. Although we typically include case-based clinical decision-making activities in our therapeutics courses, these only rarely include the practical component of seeking information, practical decision-making, and selection/labeling of a specific product. Since MyDispense simulates these exact community pharmacy operations, we sought to see if it would add value to our second-year therapeutics curriculum. The objectives of this study were to demonstrate the feasibility of integrating MyDispense into a Therapeutics course, and evaluate the effectiveness of using MyDispense on student learning.

METHODS

Therapeutics II is one of four therapeutics courses in the UCSF doctor of pharmacy curriculum. The course spans the treatment and management of common cardiovascular diseases such as hypertension, hyperlipidemia, and diabetes mellitus and is required for all second year pharmacy students. Therapeutics II employs a flipped classroom model whereby discussion of patient cases takes place during class time, after students have reviewed a pre-recorded lecture and taken an online quiz in preparation. The course runs for 10 weeks and written assessments are administered during weeks 5 and 10.

Table 1 depicts the overall study flow. In the first week of the course, the first survey was administered to assess students' confidence level in their ability to critically evaluate a prescription. After this survey, the study moved to the experimental phase.

Experimental phase. In this phase, students were randomly grouped to either MyDispense or traditional instruction (ie, paper case) for a class in week 3 by stratifying gender, grade earned in Therapeutics I, and status of repeating Therapeutics II. The learning objectives for this activity are shown in Table 2.

During the class in week 3, students were given an identical pre-test, followed by case discussion of the same patient case, and then an identical post-test. The case discussion consisted of the instructor preparing four questions to help with the evaluation and verification of the prescription and providing students up to 10 minutes to work on these in an assigned small group. Since MyDispense does not provide summarized patient case information, the MyDispense group had to gather and summarize the patient case information whereas the paper case group was directly supplied this information. Students in both groups responded to the four questions by submitting their answers via the online audience response system, PollEverywhere (PollEverywhere, San Francisco, CA). Based upon the answers submitted, the instructor then addressed any issues of misunderstanding or other challenging concepts reflected by the students.

The case, along with its answer key and accompanying feedback, were made available following the class so that students could review the post-test independently. After the post-test, the second survey was administered.

Implementation phase. In week 4, the study moved to the implementation phase. During this phase, there were two classes in each of which the entire class received one MyDispense exercise for case discussion. Two additional MyDispense exercises were offered to all students as self-study. As in the experimental phase, students were given access to the answer key and feedback to the post-test MyDispense exercise after class.

As in the experimental phase, each class had the same learning objectives and format (ie, pre-test, case discussion, post-test, published answer key). After the course, a third and final survey was administered.

Eight MyDispense exercises were created: three for pre-test, three for post-test, and two for self-study. Each pre-test exercise was paired with a post-test exercise and each pair of exercises had a comparable degree of complexity and difficulty. The self-study exercises had disease states and medications different from pre- and post-test MyDispense exercises so that students could apply their knowledge to diverse patient cases.

Each MyDispense exercise started with a brief description of patient history and the instruction to critically evaluate each medication from both a new prescription and a refill request by the patient. The exercise required gathering and summarizing relevant information, including patient refill history on the pharmacy computer, and vital signs and laboratory test results attached to the exercise. During the virtual encounter, students were required to interview the patient and search existing

Table 1. Study Flow

Phase	**Experimental**		**Implementation**			
Week Number	1	3	4	5	8	10
MyD Class		R MyD (n=62) vs Paper (n=55)	EC (n=111)		EC (n=108)	
MyD self-study			1st self-study		2nd self-study	
Survey	1st survey	2nd survey				3rd survey
Formal assessment				Midterm exam		Final exam

Abbreviations: MyD, MyDispense; R, randomization; EC, entire class; exam, examination

Each MyD class consisted of 20 minutes of pre-test, 60 minutes of patient case discussion, and 20 minutes of post-test (a total of 100 minutes). The patient case discussed in class was the same as one on the pre-test. The patient case on the post-test with its key and feedback were made available through MyDispense program immediately after class

pharmacy patient records to acquire all necessary information to fully evaluate a given prescription. Students then had to submit a final answer by writing a professional note within the online patient profile in the program regarding medications in the prescriptions they would fill and/or would not refill, along with their rationale. If they had a medication they would not fill, they needed to recommend an alternative medication, if necessary, and provide justification for their selection. Students could access the answer key and feedback only after their answers were submitted.

Each test consisted of one case and 10 multiple choice questions. Patient cases on the tests had at least five disease states including those already covered in the Therapeutics I course (eg, asthma and hypothyroidism). In addition, patient cases received 10 to 17 medications with multiple past refills documented in the pharmacy record. Each pair of pre- and post-tests had similar patient cases and medications. None of the questions were of recall type; instead, all questions were designed to assess students' ability to apply and integrate their learning. Two content experts independently reviewed the patient cases and questions to ensure a comparable level of difficulty in each pair of pre- and post-tests. The test scores were not included in students' course grade.

The tests were administered via ExamSoft (ExamSoft Worldwide, Inc, Fort Lauderdale, FL), a computer-based assessment platform familiar to the students.

Written midterm and final examinations were administered to assess students' mastery of the course materials. The midterm examination contained 25 questions with 20 multiple choice questions and five short-answer questions. The final examination had 26 questions with 21 multiple choice questions and five short-answer questions. Each examination had a maximum score of 100. Students were required to take a remedial examination if they had a final examination score below 70 or had a midterm examination score below 70 and a final examination score below 80.

Each student's MyDispense use data was obtained from Monash University. From this report, the number of completed MyDispense exercises could be determined for each student. Self-study and post-test MyDispense exercises were considered as outside-of-class MyDispense

Table 2. Learning Objectives of Classes in the Experimental Phases

1	Identify and obtain relevant patient specific information to evaluate a prescription.
2	Identify a prescription containing an inappropriate choice of medication, dosage form, dose, route, quantity, or instruction.
3	Select the best alternative to a prescription containing an inappropriate choice of medication, dosage form, dose, route, quantity, or instruction.
4	Justify the best alternative based on the patient specific information and literature evidence.
5	Provide a patient or caregiver with medication counseling at an appropriate level.

exercises. Post-tests were considered out-of-class exercises because the answer key and feedback could be accessed only after class.

Students had to complete a survey three times in this study: the first survey after the start of the course, the second survey after the experimental phase, and the third survey after the course. Email invitations were sent to the entire class inviting them to participate in the online surveys using the Qualtrics (Qualtrics, Provo, UT) platform. Although the surveys were not anonymous, students were assured that the course director would be able to access the survey data only after responses were de-identified.

Each survey contained 10 to 17 items. Of these, seven items were about their confidence level in verifying a prescription (eg, identify and obtain relevant patient specific information; identify a prescription that contains an inappropriate choice of a medication, dosage form, dose, route, quantity, or instruction, etc; available upon request). They could assess their confidence level with each item using a 7-level Likert-type scale (1=not at all confident; 4=moderately confident; 7=fully confident). All surveys contained these seven items to assess changes in the confidence level over time.

Descriptive statistics was used to determine frequency distribution, percentage distributions, means and standard deviations, and inclusive ranges as evidenced by the data.

To compare baseline characteristics between the MyDispense and usual instruction groups, Wilcoxon rank sum, Student's unpaired t-test, and chi-squared tests were used. The mean score of pre- and post-tests between the groups was compared using the unpaired t-test. Paired t-test was used to compare the mean score between pre- and post-tests administered in the implementing phase. Fisher's exact test was used to compare the confidence level between the groups.

For each time, the rating change was calculated by subtracting a score measured in the first survey from the corresponding item in the second survey.

The percent of students requiring a remedial examination between those who have completed an outside-of-class MyDispense exercise and those who have not was compared. Spearman's correlation coefficient between the number of completed outside-of-class MyDispense exercises and the sum of the formal examination scores was also compared.

SAS 9.3 (SAS Institute, Cary, NC) was used and a p-value $< .05$ was considered statistically significant.

This prospective study was declared to be exempted from full review by the University of California, San Francisco (UCSF) Institutional Review Board.

RESULTS

A total of 117 out of 124 students enrolled in the course participated in the study.

In the experimental phase, 62 students were randomly assigned to the MyDispense group and 55 to the usual instruction group (Table 3). None of the baseline characteristics were significantly different between the groups, including the percent of students currently working at a community pharmacy (36.8% in the MyDispense group vs. 34.7% in the usual instruction group).

The mean pre-test score was 6.1 out of 10 in both groups ($p=.41$; Table 4). The mean post-test score was not statistically significantly different between the groups although it was increased by 0.4 and 0.5 in the MyDispense group and in the usual instruction group, respectively.

A total of 99 students completed both the first and second surveys (response rate: 84.6%). The median scores ranged from 3 to 4 at baseline and none of the

Table 3. Baseline Characteristics of Study Participants

Characteristic	MyDispense (n=62) n (%)	Usual Instruction (n=55) n (%)	*p* value
Female	42 (67.7)	40 (72.7)	.56
Repeating course	2 (3.2)	2 (3.6)	.90
Grade in a previous therapeutics course			.77
A	6 (9.7)	6 (10.9)	
B	21 (33.9)	23 (41.8)	
C	22 (35.5)	15 (27.3)	
D	13 (21.0)	11 (20.0)	
Community pharmacy experience over 300 hrs[a]	22 (38.6)	20 (40.0)	.98
Inpatient pharmacy experience over 300 hrs[a]	18 (31.6)	13 (26.0)	.62
Currently working at a community pharmacy[a]	21(36.8)	17 (34.7)	.98

[a]Number of respondents: 57 in the MyDispense group, 50 in the usual instruction group

Table 4. Comparison of Test Score Between MyDispense and Usual Instruction Groups

Item	MyDispense (n=62) Mean (SD)	Usual Instruction (n=55) Mean (SD)	*p* value
Pre-test score	6.1 (1.5)	6.1 (1.6)	.41
Post-test score	6.4 (1.6)	6.6 (1.5)	.64
Score change from pre-test to post-test	0.4 (1.8)	0.5 (1.8)	

scores were statistically significantly different between the groups (Table 5). The median score change ranged from 0 to 1 but none of the score changes were significantly different between the groups. For the two items in the second survey, "evaluate a prescription in a time-sensitive manner" and "apply knowledge to develop a therapeutic plan," the MyDispense group had a median score of 3 whereas the usual instruction group had 4 (both items $p<.001$).

During the implementation phase, in the first of the two classes with MyDispense, 111 students participated. The mean post-test score was significantly higher than the mean pre-test score Mean (SD): 6.0 (1.4) vs 4.0 (1.4), $p<.0001$. In the second class, where 108 students attended, the mean post-test score increased compared with the mean pre-test score, 6.3 (1.4) vs 5.9 (1.9), $p=.054$.

In the third survey, 108 students participated. Less than 30% of the students felt that MyDispense was helpful for applying knowledge to evaluate and process a prescription in a timely manner or to develop a patient-specific drug therapy plan. Of the five learning objectives, using MyDispense was most helpful in identifying and gathering relevant patient specific information (Table 6). The two most useful features of MyDispense were its capability to provide immediate feedback and to be accessed at any time and place for practice, whereas its inability to simulate pharmacy practice in a non-community pharmacy setting and its limited capability to authentically simulate interactions with patients and prescribers were selected as the two least useful features. Compared with MyDispense exercises, more than 77% of students found paper cases more useful in applying therapeutic knowledge and skills to accurately evaluate and process a prescription in a timely manner or to develop a patient-specific drug therapy plan. Only 20.7% of students would like to see MyDispense integrated into a therapeutics course. If MyDispense was to be integrated into a therapeutics course, 73.6% of students preferred it to be for self-study.

Of five outside-of-class MyDispense exercises, 44 students (37.6%) made no attempt at an exercise, 11 (9.4%) attempted one exercise, 7 (5.9%) two exercises, 12 (10.3%) three exercises, 12 (10.3%) four exercises, and 31 (26.5%) all of them. The number of attempts at completing outside-of-class MyDispense exercises was moderately correlated with the sum of the written midterm and final examinations scores (Figure 1: Spearman's coefficient=0.30; $p=.0009$).

There were 11 students who were required to take a remedial examination after the course. Of them, 10 (90.9%) made no attempt at completing an outside-of-class MyDispense exercise. In contrast, of 106 students who passed the course, 32.1% made no attempt at completing an outside-of-class MyDispense exercise ($p<.0001$).

Table 5. Comparison of Confidence Levels in Critically Evaluating Prescriptions Between the Groups

Item	MyDispense (n=53)		Usual Instruction(n=46)		*p* value[b]
	Baseline	Change[a]	Baseline	Change[a]	
Obtain relevant patient information	4 (3-5)	0 (0-1)	4.0 (3-5)	0 (0-1)	.50
Identify an inappropriate prescription	4 (2-4)	1 (0-2)	4 (2-4)	1 (0-1)	.77
Select the best alternative	3 (2-4)	1 (0-2)	3 (2-4)	1 (0-2)	.22
Justify the best alternative	4 (2-4)	1 (0-2)	3.5 (2-5)	0 (0-1)	.15
Provide medication counseling	4 (3-4)	0 (0-1)	4 (3-5)	0 (0-1)	.94
Evaluate a prescription in a timely manner	3 (2-4)	1 (0-2)	3 (3-4)	0 (0-2)	.48
Apply knowledge to develop a therapeutic plan	3 (2-4)	1 (0-2)	3 (2-4)	0.5 (0-2)	.19

Data are expressed as median (interquartile range)

[a]The rating change was calculated by subtracting rating measured in the first survey from rating measured in the second survey

[b]This is comparison for the changes in the confidence level from the first survey to the second survey

Table 6. Students' Perception of the Use of MyDispense in a Therapeutics Course

Item	Class Responses (N=108) n (%)
Learning objectives MyDispense helps achieve [a]	
Identify and obtain relevant patient specific information	36 (35.0)
Identify a prescription containing an inappropriate chose of medication, dosage form, dose, route, quantity, or instruction	29 (28.2)
Select the best alternative to a prescription containing an inappropriate chose of medication, dosage form, dose, route, quantity, or instruction	12 (11.7)
Justify the best alternative medication based on the patient specific information and literature evidence	11 (10.7)
Provide a patient or caregiver with medication counseling to an appropriate level	15 (14.6)
Two most useful features of MyDispense[a]	
Receive immediate feedback	58
Practice anytime and any place	35
Identify and obtain patient specific information	33
Provide a safe environment to practice	33
Practice processing a prescription	26
Practice counseling on medications	13
Two least useful features of MyDispense[b]	
Simulate only community pharmacy practice	55
Does not simulate true interactions with patients and prescribers	41
Require me to summarize relevant information on my own	35
Require me to identify and obtain relevant patient information	21
Require a patient avatar to provide laboratory test results	18
Receive feedback after submitting an answer	16

[a]Five students did not respond to this item
[b]Not all respondents selected two choices

DISCUSSION

In this study, we demonstrated the feasibility of using MyDispense into a therapeutic course as a tool for vertical curricular integration. We had mixed findings regarding its effectiveness on student learning in this context. Although using MyDispense in class improved test scores in the implementation phase, when it was compared with the paper case-based discussion in the experimental phase, it did not significantly increase students' test scores or confidence levels in critically evaluating and verifying a prescription. In addition, over 77% of students did not feel that it was helpful for application of therapeutic knowledge for evaluating a prescription or developing a therapeutic plan. The number of attempts to complete outside-of-class MyDispense exercises was moderately correlated with academic performance. In addition, students felt that using MyDispense helped achieve a learning objective, which in a paper case-based discussion would have been difficult – more specifically, identifying and gathering relevant patient-specific information.

Less than 30% of students felt that MyDispense was helpful for applying knowledge to evaluate and process a prescription in a timely manner or to develop a patient-specific drug therapy plan despite the significant correlation between the number of attempts at completing outside-of-class MyDispense exercises and formal assessment scores. Based on the Kirkpatrick Model, these findings suggest that although overall student reaction to using MyDispense was not positive, it may have had positive influence on their learning.[10,11] The key feature which distinguishes MyDispense exercises from paper-based cases is its capability to provide students an opportunity to gather and summarize the patient-specific information on their own. This is confirmed by the survey results showing that identifying and gathering relevant patient-specific information was the top learning objective that MyDispense helped students to achieve. Since the formal written examinations mostly consisting of multiple choice questions were not specifically designed to assess these skills, students may have felt that additional time and effort to seek patient information from MyDispense exercises makes their study inefficient and unhelpful. Given that novice learners may not recognize the importance of these critical skills, they may not appreciate this additional time and

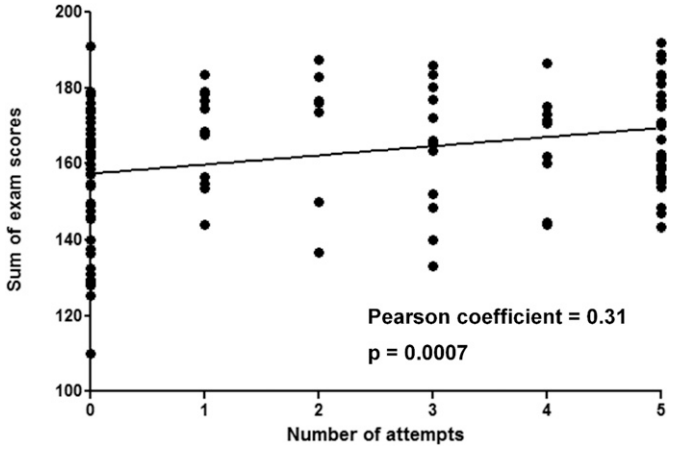

Figure 1. Correlation of the number of attempts to complete an outside-of-class MyDispense exercises and sum of written midterm and final examinations scores (Pearson coefficient=0.31, p=.0007).
Since each examination had a maximum score of 100, the maximum total sum of these two examinations score would be 200.

effort required to put when they used MyDispense. It would be interesting to evaluate how helpful using MyDispense would be for students to apply their knowledge and skills to patient care during Advanced Pharmacy Practice Experiences. In addition, our findings suggest that assessing these skills on the formal examinations by using an appropriate format of questions is important in students' adoption of using MyDispense in a therapeutics course.

Simulation has been widely adopted by many pharmacy schools around the world. For example, Vyas and colleagues reported that 84% of US pharmacy schools use a high fidelity simulation in their curriculum.[12] However, other studies have reported conflicting results about simulation's effectiveness on student learning as compared to other teaching methodologies, so it is important to evaluate the effect of a new simulation on student learning before it is fully adopted.[13-16] In our study, MyDispense exercise-based discussion in class for a short term did not improve test scores and confidence levels compared with paper case-based discussion. There may be several reasons for this finding. First, in the experimental phase, the two groups only had an hour difference in the extent of the exposure to MyDispense in class and this difference may not have been sufficient to see its effect.[17] Second, MyDispense may fit better for self-study given that it does not have a geographic or temporal limitation for access and provides immediate feedback. This is also supported by the students' survey results. It remains to be seen whether using MyDispense for self-study would improve student learning and confidence level.

Our study confirms the useful features and limitations of a simulation. As in the previous studies, receiving immediate feedback, accessing exercises without a geographical or temporal limitation, providing a safe environment, and practicing processing a prescription were identified as useful features of MyDispense.[8,17-20] Like many simulation programs, MyDispense has a limited scope of simulation as it does not simulate hospital pharmacy practice or an authentic interaction with other health care providers and patients. When implementing a simulation in a course, course directors should consider its useful features and limitations to determine the best way for its incorporation. For example, given the limited scope of simulation, MyDispense may be best integrated with a course related to community pharmacy practice. In addition, when a simulation is used for vertical curricular integration as in our study, continuous usage within the curriculum may help with students' learning and adoption of it. For example, although MyDispense was used in the Pharmacy Law course in the fall quarter of the first year of our PharmD program, it was not reinforced until the spring quarter of the second year. Because of this nearly 1.5-year gap, students may have been distracted from their studying to re-learn how to use MyDispense. As a result, they may not have seen it as an integral part of the course.

In our study, the integration of MyDispense increased the faculty workload manageably. It was our workflow that a paper case was created before it was integrated into MyDispense. As a result, the difference in workload between creating a paper and a MyDispense cases would be additional time to integrate a paper case into MyDispense. This took about 30 minutes for a case.

Our study has the following strengths. We used a stratified randomization method and a control group to evaluate the effectiveness of using MyDispense in class. We measured both student test scores and confidence levels over time. We used different cases and test questions for pre- and post-tests and had them validated by two experts. We offered two different ways of using MyDispense exercises (ie, in-class discussion and self-study) to explore optimal ways to implement MyDispense in a therapeutics course. Finally, we correlated formal examination scores with the number of attempts to complete outside-of-class MyDispense exercises.

We acknowledge the following limitations. First, we only had an hour difference in the exposure to MyDispense between the groups in the experimental phase. If we had had multiple classes in the experimental phase, it would have made it difficult to have large student participation,

as students would have thought using MyDispense to be superior. Second, we did not effectively assess skills in gathering and summarizing relevant patient-specific information on our formal assessment as short answer type questions, which may assess these skills better than multiple choice type, required more resources for grading. Finally, we were not able to establish a cause and effect relationship between the formal examination scores and the number of attempts to complete outside-of-class MyDispense exercises as the latter could be a marker of student motivation for learning.

CONCLUSION

Although MyDispense could be integrated into a therapeutics course, using it for a short time in class did not improve student test scores and confidence level in critically evaluating a prescription. The number of outside-of-class MyDispense exercises students made attempts at completing was moderately correlated with the formal examination scores. In addition, it has useful features and limitations such as providing immediate feedback and simulating only community pharmacy practice. These data suggest that MyDispense may be best integrated in a therapeutics course as self-study. For more successful integration, it should be used throughout the curriculum, and assessment methods sensitive to skills in gathering and summarizing relevant patient-specific information should be developed.

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