REVIEW

An Integrative Review of Approaches Used to Assess Course Interventions

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Submitted September 20, 2021; accepted January 21, 2022; ePublished January 2022

Objective. The objectives of the review are to (1) describe the utility of approaches used for the assessment of course interventions in pharmacy education; and (2) provide recommendations that may guide faculty members in their future scholarship of teaching and learning (SoTL) efforts that encompass assessment of course interventions.

Findings. Thirty-four articles that included educational interventions published between 2016 and 2020 in the *American Journal of Pharmaceutical Education* and *Current in Pharmacy Teaching and Learning* were selected for analysis. Those articles used various approaches for the assessment of course interventions. In the order of decreasing frequency of use, those methods were surveys, student academic performance, student evaluations, mixed quantitative- and qualitative methods, pre- and post-test, and learning analytics.

Summary. The use of more than one assessment approach, ie, triangulation, and multiple student cohorts, are advantageous. When multiple cohorts are used, it is beneficial to present the students' demographic information. Student academic performance should be part of an assessment of course interventions whenever relevant. Surveys about student perceptions and confidence may contribute to the assessment of course interventions. However, since the information collected is subjective and is usually unrelated to student learning, such an approach should be coupled with other assessment approaches that reflect student learning, such as academic performance and/or a pre- and a post-test. Depending on the research question, qualitative methods and learning analytics may also be a part of the assessment of a course intervention.

Keywords: course intervention; course assessment; student evaluations; measures of learning; learning analytics

INTRODUCTION

The Scholarship of Teaching and Learning (SoTL) encompasses studies on various topics such as student learning, assessment, curriculum, health disparities and cultural competency, wellness, and professionalism.¹ A certain type of SoTL study involves the description and assessment of courses,² and in particular courses that underwent an intervention to improve learning outcomes or were newly implemented. Since after several years of teaching faculty members develop expertise in the course instruction and may experiment in introducing classroom innovations, this type of study may serve faculty members who are novices to SoTL as a possible gateway to the discipline. Moreover, faculty members who have already experimented with SoTL but have not yet published their teaching innovations may wish to expand their SoTL program by doing so. As they consider the assessment of their instructional innovations, faculty members should be aware of the following approaches:

Academic performance – Academic performance in courses usually includes student deliverables, such as assessment scores and/or course final letter grades.³ This approach is convenient because the SoTL assessment is embedded in the course.⁴

Pre- and post-test – This quantitative approach involves the administration of a test prior to and after an intervention to the same group of students.^{3,5} An advantage of this approach is that it may confirm that knowledge was acquired during the intervention.⁶ Disadvantages of this approach are that it does not allow conclusions whether the method is equivalent, superior, or inferior to other forms of instructions, and it may be difficult to conclude whether the effects are simply due to time (eg, student maturation) or the intervention.⁵

Surveys – Surveys may be administered after an intervention, or as a pre- and post-survey.^{3,7,8} Surveys may include quantitative questions^{9,10} (eg, Likert scale), and/or questions in the form of free-text items to provide written feedback that can be assessed in qualitative methods.^{3,8,9} Surveys frequently inquire about subjective, self-reported measures such as student perceptions or attitudes regarding an intervention,^{8,9} or changes in confidence levels regarding

abilities that were acquired during an intervention.³ Validated survey instruments may be obtained from the literature or via certain vendors. However, in the cases of course intervention because the intervention is very specific, educational researchers will most likely need to design a survey.⁸ A disadvantage of surveys is that because the information collected is subjective,⁸ it may not reflect student learning,⁵ and better understanding and enhancement of student learning were noted as the main reasons behind SoTL.^{5, 9, 11}

Student evaluations of teaching – Similarly to surveys, student evaluations may include quantitative and qualitative questions. Differences in the information collected among various institutions affect the possible contribution of the evaluations to the assessment of course interventions. Some institutions may allow a researcher to add items related to the intervention into the student evaluations.^{3, 12} An advantage of student evaluations is that they are administered every year. In the case of a course intervention, this allows the researchers to use evaluations that were collected prior to the intervention as a control group. Institutional Review Boards (IRBs) may approve the use of student evaluations (as well as other course-related data) that were collected before the research was initiated as a usage secondary to its routine utilization for educational purposes.^{4, 8} A disadvantage of student evaluations is that by nature they collect subjective information, which is not directly linked to student learning.^{3, 13} Additional disadvantages are that evaluations are affected by gender and race of the faculty member;³ unlike surveys that are tailored toward a certain intervention, student evaluations inquire about general course attributes; and particularly in the cases where the intervention is only part of a course, the information collected regarding an intervention may be limited.

Qualitative studies – Qualitative study designs may encompass a collection of written information such as student reflections or data collected from interactions with students such as interviews or focus-groups.^{8, 10, 14} Responses to free-text items⁹ in surveys or student evaluations may also be analyzed in qualitative methods, such as thematic analysis.^{8, 10, 12, 14-16} The design and execution of qualitative studies require expertise that may be more specialized than other described methods.^{5, 14}

Mixed methods – This term refers to the combination of quantitative and qualitative methods in the same study design.^{2, 9, 10, 14} It was suggested that the use of mixed methods is advantageous as it can potentially provide a wider view of the research question by allowing triangulation of findings.^{8, 9}

Learning analytics – A standard definition of learning analytics is the “measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs”.¹⁷ Unlike academic performance that usually includes grades or performance data, learning analytics refer to the collection and analysis of data about learners and their environments for the purpose of understanding and improving learning. For example, correlating frequency of learning activities such as software usage data with academic performance,¹⁸ or grouping of assessment questions into topics with the subsequent correlation of student success rates in solving the questions with various teaching approaches.¹⁹ The utilization of learning analytics in SoTL is more recent, and it may contribute to the assessment of course interventions.^{9, 17}

We conducted a literature search in the pharmacy education literature to identify articles that may support faculty members engaged in SoTL.^{6, 7} This search did not uncover a review article that specifically focuses on the assessment of course interventions, or suggests better practices for the assessment of course interventions. Therefore, this review article aims to (1) describe the utility of approaches used for the assessment of course interventions in pharmacy education; and (2) provide recommendations that may guide faculty members in their future SoTL efforts that encompass assessment of course interventions.

METHODS

A literature search was conducted, primarily based on article titles, in the websites of the journals, *American Journal of Pharmaceutical Education* and *Currents in Pharmacy Teaching and Learning*. The search was limited in time from August 2016 to August 2021 to capture contemporary methodologies. The aim was to identify articles from each of the two journals about interventions in existing courses or the implementation of new courses. Due to a limitation on the number of references in the article, it was decided that for this part of the review 17 articles will be cited from each journal and that those 17 articles will be similarly divided between articles about interventions in existing courses and articles regarding the implementation of new courses. While considering this structural design, the main criterion for inclusion was time, and more recent articles were preferred. Articles about experiential education and objective structured clinical examinations (OSCEs) were excluded. A few additional articles were excluded because of unclear methodologies. Next, a literature search was conducted in Google Scholar and Educational Resources Information Center (ERIC) to identify articles that provide general information regarding the assessment of course interventions outside of pharmacy or health care education. The terms used for this search were SoTL research design, SoTL getting started, SoTL learning analytics, and student evaluations teaching effectiveness. Google Scholar was also used to identify articles that cite some of those articles that were previously identified. Moreover, a search was conducted on amazon.com using the term

scholarship of teaching and learning to identify books about SoTL. Book chapters regarding the assessment of course interventions from books that were not part of the library collection were ordered via an inter-library loan service.

RESULTS AND DISCUSSION

Table 1 describes approaches used in articles (n=17) to assess intervention in existing courses, and Table 2 describes approaches in articles (n=17) to assess the implementation of new courses. Table 3 summarizes the various approaches that were used to assess course interventions with respect to the frequency of use. As seen in Table 3, the approaches to assess course interventions, in descending order of frequency of use, were survey administration, academic performance, student evaluations, mixed methods, pre- and a post-test, and learning analytics.

The review focused on a certain type of articles where researchers describe innovations in their own teaching. The literature suggests that an instructor's own teaching is an appropriate place to start SoTL efforts,^{2, 11} that conducting SoTL on one's own teaching is common,^{2, 4} and that such studies are important for the SoTL discipline.⁵

As pharmacy educators who wish to conduct SoTL frequently encounter challenges related to their lack of formal training in SoTL,⁷ the challenge of choosing appropriate methodologies was also noted for SoTL beyond pharmacy education.¹¹ An example of such a challenge is the design of an appropriate control group.² The current review revealed that it is common to use cohorts prior to the intervention as a control group.¹⁹⁻²⁴ Changes between the cohorts beyond the intervention may hamper such a use.^{3, 21} With the lack of such changes, it suffers from a limitation that no two classes are identical, even when the course is taught by the same instructor who presents the same lectures.⁵ Nevertheless, a comparison with previous cohorts is still an acceptable approach despite its inherent limitations.⁴ The included studies used, on average, more than two approaches to assess the course intervention. Triangulation was already suggested in the literature regarding SoTL of pharmacy¹⁰ and beyond as a valid approach, which may be advantageous.^{8, 9}

Academic performance was used most commonly. Examples of metrics that were used to study the academic performance were average final course scores,^{20, 25-27} a range of final course scores,^{28, 29} average student scores on various course assessments such as examinations,^{20-22, 24-26, 30, 31} quizzes,^{20, 23, 32, 33} or other assignments.^{20, 26, 27, 33, 34} In a few cases where the course intervention was limited to a certain part of the course the metric used to assess academic performance was not the entire assessment but the score on a group of questions that were related to the intervention.^{19, 23, 30} Final course letter grades^{20, 21, 25} and the number or percentage of students who passed or failed examinations^{21, 22, 31} were also used as metrics for academic performance. Examples of other, less common metrics that were used are overall first attempt passing rate on quizzes,²³ and quality of reflection activities.²⁹ The use of academic performance is convenient as it is collected as part of the course that is under study.⁴ Compared to the other approaches, academic performance is a better proxy of student learning.³

A different approach that may be used as a proxy for student learning is the pre- and post-test, which was not commonly used in the studies (Table 3). In the case where the intervention was only part of the course, items from the final examination related to the intervention served as a post-test and were administered as the pre-test.^{3, 34} However, even in the case of the implementation of a new course, there is no need to use the entire final examination as the post-test that should also be administered as a pre-test.⁴ Due to time constraints related to the pre-test, it is possible to randomly select items from the final examination for the administration of a pre-test.

Survey administration is a valid approach to assess a course intervention. Most of the articles that we analyzed relied on instructor-developed surveys and not on validated surveys obtained from a source external to the study. Those surveys inquired students about subjective measures such as their perceptions and attitudes regarding the intervention, satisfaction and/or interaction with the intervention, or confidence regarding topics covered in the intervention (Table 3). It was common for surveys to include free-text items^{12, 15, 16, 18, 23, 27, 34-37} that in a few studies were used for a qualitative thematic analysis.^{12, 15, 16} Frequently, the description of survey results included the survey questions and student responses.^{12, 15, 18, 23, 27, 31-34, 38-44} Depending on the research question there may be a need to administer a pre- and a post-survey. This may be particularly important when the survey measures changes from a baseline prior to the intervention. Hence, in all the studies that appear in Table 3 that included a survey about confidence the survey was administered as a pre- and post-survey. As suggested in the literature⁴⁵ and conducted in some of the studies that we analyzed,^{28, 32, 35, 39, 42} it is advantageous to pretest the survey on a group of students who are potential responders to the survey.

Some of the studies in Table 3 that included survey administration collected basic demographic information such as the respondents' age and/or gender.^{27, 28, 30, 31, 38, 41, 42, 46} Several studies asked about past experiences related to the intervention,^{27, 30, 32, 33, 41, 42} such as prior participation in a course that may have provided background information to the students.^{46, 47} An advantage of a report regarding demographics³ is that it enables a better understanding regarding the generalizability of the study,⁵ in particular when studies regarding a course intervention by nature almost always describe a course in one institution, with only one exception in the articles that we analyzed.⁴⁸ A report regarding demographics,

including measures of academic performance such as incoming Grade Point Average (GPA) and/or cumulative GPA, should also be considered when one or more cohorts prior to the intervention are used as a control group to ascertain that the classes are similar in that respect.⁷

Student evaluations may also play a role in the assessment of course interventions. The three major approaches in the description of student evaluations were to generally describe the evaluations as a whole or in part,^{15, 22, 24, 30, 36} to present evaluation scores; and/or to delineate the students' written comments. In the presentation of evaluation scores, various studies provided different metrics, such as one score that averaged all items regarding the instructor^{20, 21} or the course;^{20, 26, 32} average scores for different items regarding the course^{24, 28, 29, 32} or both the course and the instructor;^{25, 36, 49} or average scores for one item regarding the course.^{15, 30} In the presentation of student comments the main approaches were to provide a summary of the comments,^{20-22, 24, 26, 30} excerpts from the comments,^{25, 26, 28, 29, 44} or both.⁴⁹ One study, which collected student evaluations from seven years, conducted a qualitative thematic analysis to excerpts from student evaluations²⁹ as mentioned above for responses to free-text items in surveys. Several studies mentioned not only the positive student comments but also the negative or opportunities for course improvement.^{20, 24, 25, 44} From a SoTL perspective, there may be greater significance to information that stems from student responses to free-text items compared to numerical values. The reason is two-fold: First, free text yields much richer data that can help identify causes or rationale. Second, student evaluations have come under scrutiny as there may be various biases as described above.¹³

As seen in Table 3, with one exception²⁹ all studies that utilized qualitative methods essentially used mixed methods as they also used quantitative methods. Qualitative methods utilized can generally be divided into those that rely on written documentation, which was more commonly used, and those where the information was collected through interaction with students, such as interviews^{39, 42} or focus groups.^{30, 48} Documents used for qualitative analysis were student reflections,^{43, 48} student responses to free-text items in surveys,^{12, 15, 16} and student evaluations as mentioned above.²⁹ In one study, student responses to free-text items in their evaluations were compared to results obtained from focus groups.³⁰ Qualitative methods were less commonly used than most other approaches to assess course interventions. As mentioned above, this may be related to the fact that mastery in the use of qualitative methods requires a more specialized training, and/or to the possibility that the training of pharmacy educators in basic- or clinical sciences leads them to prefer quantitative research, which may be subject to statistical analyses.^{2, 9}

Among the studies that we analyzed, the (relatively uncommon) use of learning analytics included various components. One study assessed the number of students who interacted with the intervention by extracting from a freeware information about the extent of completion of optional exercises. Subsequently, usage data was correlated with scores on examination questions relevant to the intervention.¹⁸ A more traditional approach in the usage of learning analytics was described in a study that used the Learning Management System to obtain student grades from select courses before, simultaneous with, and after the intervention to compare students who participated in an intervention to those who did not.³⁷ A similar analysis was conducted in a study regarding a journal club elective that assessed the effect of participation in the course on overall Pharmacy Curriculum Outcomes Assessment (PCOA) scores, PCOA scores in two certain areas, and overall course scores in three courses, which were administered after the elective.⁴⁷ In a recent study, learning analytics were applied to pharmacy calculations to calculate the success rates of students in solving examination questions based on topics and to correlate those success rates with the approach that students used to solve calculation questions. The design of this study was atypical as it relied on the instructor teaching two approaches for problem-solving to the entire class and the students choosing which approach to use for each topic.^{50 18, 19}

Other studies used approaches for assessment of intervention that were more specific to their courses. A study about a Sterile Compounding course included a metric of changes in laboratory expenses.²⁴ An elective entitled Pharmaceutical Care in Indigenous Health assessed its ability to attract students and meet the cap on the number of participants since the course inception.²⁹

A limitation of the review is that the number of articles that we analyzed was limited. Moreover, considering the design that we used to select articles for analysis (similar number of articles from each journal, and for interventions in existing courses versus the implementation of new courses), articles were selected mainly on a chronological basis. However, it is possible that other authors might have selected different articles. Nevertheless, the conclusions would have likely been very similar even with a slightly different selection of articles. Another limitation is that due to the relatively small number of articles that we analyzed, and the described structural design, we were unable to track changes in the approaches used for the assessment of course interventions over time.

CONCLUSION

The analysis of articles about the assessment of course interventions that we conducted leads to the following recommendations:

- We recommend the use of more than one assessment approach, ie, triangulation, to assess course interventions.

- We recommend the use of multiple cohorts whenever possible, particularly when the class size is relatively small (eg, < 100 students).
- When comparing a course after intervention to a historical control, we recommend the comparison of student academic performance and student evaluations. If during multiple course iterations some of the examination questions are unchanged, then question tagging may be used to study student performance on those questions. Institutional review boards may approve such studies not only prior to the intervention (with a retrospective component of previous cohorts) but also after the intervention was completed. However, the opportunity to use additional assessment approaches such as surveys or a pre- and post-test may not be available at that point.
- If the intervention is optional in a required course, or the intervention is an elective course, non-participants may be used as a control group. In addition, academic performance on blocks from the same course that did not undergo the intervention or on a different course from the same course sequence that the instructor taught without intervention may also be used as a control group.
- When multiple cohorts are used, it is advantageous to present demographic information such as incoming GPA or cumulative GPA to assess similarity in baseline skills and knowledge. An advantage of cumulative GPA over incoming GPA is that the former represents academic performance from the same institution and therefore provides more consistent information regarding the different cohorts.
- Student academic performance should be part of an assessment of course intervention whenever relevant. When the intervention is a new course then assessment scores and/or final course scores may be used. Final course letter grades, a less sensitive metric that can still demonstrate the class's overall performance, may also be used. When the intervention is a change that affects only part of an existing course, then student performance on assessment questions related to the intervention may be compared to their performance on assessment questions unrelated to the intervention. However, adequate sampling of that topic would be needed.
- A pre- and a post-test may be an acceptable assessment approach for course interventions when there is a control group such as students from a different cohort. Without the control condition a pre- and a post-test design may demonstrate student learning, but not the extent of intervention effectiveness.
- Surveys about student perceptions and confidence may contribute to the assessment of course interventions but rarely are sufficient to demonstrate improved student learning. A survey about confidence levels should be administered both before and after the intervention to identify possible changes.
- When using surveys, if the researchers are unable to find a validated survey that satisfies their specific needs, to enhance the validity of an instructor-developed survey it should undergo a thorough review by peers with subsequent pretesting on a group of student pharmacists. Such a survey may collect demographic information regarding previous student experiences related to the intervention (eg, prior participation in a course that provided background information to the students). Moreover, the presentation of demographic information such as age and/or gender may demonstrate the possible generalizability of the study.
- Qualitative methods may provide a deeper understanding of the student experience. Hence, depending on the research question, qualitative methods may be used as the only assessment strategy or in a mixed-methods design. Since the design and execution of such studies require specialized training, it is desirable to consult or collaborate with researchers that are experienced in such studies and/or refer to published guidance on reporting qualitative data.
- Student evaluations may be added as a minor contributor to the assessment of course interventions. A summary of student comments with the optional addition of excerpts, with or without opportunities for course improvement, may be provided. Numerical values are most helpful when the intervention relates to an entire existing course (eg, a course overhaul) and the previous cohorts serve as a control group.
- Depending on the research question, learning analytics may be a part of the assessment of a course intervention. Researchers should be aware of data (including usage data) that may be obtained from their Learning Management System, online examination software, platforms that are used by the institution (eg, for lecture recording, remote teaching, or student polling), and other applications that may be used in their courses; and to opportunities to use such data. It is noteworthy that not all institutions have access to the same analytics. The lack or limited accessibility to appropriate data may prevent the execution of some potential analyses or research projects.
- Assessment of intervention in some specific courses may be conducted by more unique approaches.

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Table 1. Approaches Used in Articles (n=17) to Assess Interventions in Existing Courses

Course	Intervention	Assessment(s)	Reference
Pharmaceutical Calculations	Creation of six video podcasts with a stepwise demonstration of the solution of the six most challenging quiz problems	1. Academic performance 2. Survey about student interaction with the intervention and their perceptions about the intervention. Survey included a free-text item	23
Integrated medicinal chemistry and pharmacology	Five enrichment activities were offered to students	1. Pre- and post-survey about student perceptions and confidence. Survey included free-text items	35
Pharmacotherapy I	Optional peer feedback activity	1. Survey about student attitudes and perceptions 2. Qualitative: interviews	42
5-week oncology elective module	An interactive activity was created to represent various oncology practice settings	1. A pre- and post-survey about perceptions and confidence	41
Basic and Clinical Pharmacogenomics	Participation in optional student-led study groups	1. Academic performance 2. Different surveys about student perceptions were administered pre- and post-course	31
Pharmaceutical Calculations	Provision of formative feedback using video podcasts versus typed solutions	1. Survey about student perceptions. Survey included free-text items (qualitative analysis)	12
Chemical Basis of Drug Action	Incorporation of Pharmacist Patient Care Process	1. A pre- and post-survey about student perceptions. The post-survey encompassed additional items about student perceptions, which included some free-text items (qualitative analysis) 2. Pre- and post-test 3. Student evaluations	15
Intermediate Pharmacy Skills and Applications	Mechanical and mathematical challenges	1. Survey about student confidence that also had free-text items (qualitative analysis)	16

Sterile Compounding	Changes to instruction and assessment methods (including simulations)	1. Academic performance 2. Student evaluations that included free-text items 3. Changes in laboratory expenses	24
Pharmacy law	Incorporation of MyDispense (an online freeware) optional exercises	1. Academic performance 2. Learning analytics 3. Survey about usage of intervention and perceptions. Survey included free-text items	18
Basic Communication Skills for Pharmacy Practice	Addition of active learning exercises	1. Pre- and post-PCRA-24	46
Principles of Drug Action I	Flipped classroom approach	1. Academic performance 2. Student evaluations that included free-text items	22
Pharmacology and Medicinal Chemistry 2	Incorporation of flipped classroom activities	1. Academic performance 2. Learning analytics 3. Survey about student perceptions	19
Pathophysiology	Banning of computers during class time	1. Academic performance 2. Course evaluations that included free-text items	21
Principles of Pharmacology	Addition of recitations to lectures	1. Academic performance 2. Student evaluations that included free-text items	20
Skills laboratory	Addition of an active-learning session about pharmacogenomics	1. Academic performance 2. Pre- and post-survey about confidence. The post-survey encompassed additional items about perceptions, which included some free-text items 3. Pre- and post-test	34
Pharmacotherapeutics	Flipped examination, i.e., students developed the assessment	1. Pre- and post-survey 2. Academic performance 3. Qualitative: focus groups 4. Student evaluations that included free-text items	30

PCRA-24=Personal Report of Communication Apprehension

Table 2. Approaches Used in Articles (n=17) to Assess the Implementation of New Courses

Course	Assessments	Reference
PBL acute care elective	1. Academic performance 2. Learning analytics 3. Survey about perceptions that included free-text items	37
Pharmaceutical Care in Indigenous Health elective	1. Academic performance 2. Student evaluations that included free-text items (qualitative analysis) 3. Enrollment data	29
Mental health first aid elective	1. Pre- and post OMS-HC survey 2. Qualitative: reflection	43
Surveys of Multi-Modality Imaging elective	1. Pre- and post-survey about confidence and perceptions 2. Student evaluations that included free-text items	44
Health Promotion and Disease Prevention Across Cultures elective	1. Pre- and post-survey about confidence 2. Pre- and post-test 3. Academic performance	38
Pharmaceutical industry practice elective	1. Pre- and post-survey about perceptions and confidence 2. Academic performance 3. Student evaluations	32
Journal club elective	1. Learning analytics	47
Aspects of Caring for the Pain Patient elective	1. Pre- and post-course survey about attitudes and perceptions 2. Academic performance	40
Drugs in Sport elective	1. Survey about perceptions 2. Qualitative: interviews	39
Women's reproductive health elective	1. Academic performance 2. Pre- and post-survey about perceptions and confidence 3. Student evaluations	28
Advanced MTM Certificate Course elective	1. Academic performance 2. Pre- and post-survey about perceptions and values 3. Survey about satisfaction	33
Ethnopharmacology of Appalachia elective	1. Academic performance 2. Student evaluations	26
Applied Secondary Database Analysis research elective	1. Academic performance 2. Survey about student satisfaction and confidence that included free-text items	27
Academic Pharmacy elective	1. Academic performance 2. Student evaluations 3. Student post-course reflections 4. A survey, which included free-text items, 1-2 years after the course	36
Creative Thinking for Innovation elective	1. Pre- and post TTCT 2. Academic performance 3. Student evaluations that included free-text items	49
Cardiovascular Electrophysiology: From Bench to Bedside elective	1. Academic performance 2. Student evaluations that included free-text items	25
Diabetes Prevention elective	1. Pre- and post-test 2. Pre- and post-survey about confidence 3. Qualitative: reflections 4. Qualitative: focus groups	48

MTM=medication therapy management

OMS-HC=Opening Minds Scale for Health Care Providers

PBL=problem-based learning

TTCT=Torrance Test of Creative Thinking

Table 3. A Summary of Approaches Used to Assess Course Interventions

Approach [†]	Changes in Existing Courses		Implementation of New Courses		Total Frequency (no., percent)
	Frequency (no., percent)	References	Frequency (no., percent)	References	
Pre- and post-survey	7/17, 41%	15, 30, 31, 34, 35, 41, 46	8/17, 47%	28, 32, 33, 38, 40, 43, 44, 48	15/34, 44%
Post survey	6/17, 35%	12, 16, 18, 19, 23, 42	5/17, 29%	27, 33, 36, 37, 39	11/34, 32%
Academic performance	10/17, 59%	18-24, 30, 31, 34	12/17, 71%	25-29, 32, 33, 36-38, 40, 49	22/34, 65%
Student evaluations	6/17, 35%	15, 20-22, 24, 30	8/17, 47%	25, 26, 28, 29, 32, 36, 44, 49	14/34, 41%
Qualitative: written	3/17, 18%	12, 15, 16	3/17, 18%	29, 43, 48	6/34, 18%
Qualitative: oral	2/17, 12%	30, 42	2/17, 12%	39, 48	4/34, 12%
Pre- and post-test	2/17, 12%	15, 34	3/17, 18%	38, 48, 49	5/34, 15%
Learning analytics	2/17, 12%	18, 19	2/17, 12%	37, 47	4/34, 12%
Other	1/17, 6%	24	1/17, 28%	29	2/34, 6%

[†]Seventeen articles were identified for changes in existing courses and implementation of new courses; see Table 1 and Table 2, respectively