Available online at www.sciencedirect.com

ScienceDirect

Currents in Pharmacy Teaching and Learning 7 (2015) 729–737

Currents in Pharmacy Teaching & Learning

http://www.pharmacyteaching.com

Research

A pre- and post-test assessment of concept learning in research design

Jill M. Augustine, PharmD, MPH*[,a], Marion Slack, PhD[b], Terri L. Warholak, PhD[b]

[a] Department of Pharmaceutical Sciences, University of Arizona College of Pharmacy, Tucson, AZ

[b] Department of Pharmacy Practice and Science, University of Arizona College of Pharmacy, Tucson, AZ

Abstract

Objective: To assess concept learning and topic difficulty in a concept-based research methods course.

Methods: A pre–post exam was given to second professional year Doctor of Pharmacy students enrolled at the University of Arizona College of Pharmacy using 25 concept-based multiple choice questions. Rasch analysis was used to determine the change in student ability and to assess question difficulty.

Results: A total of 94 students completed both pre- and post-tests (response rate = 96.9%). As a group, student ability significantly increased from the pre- to post-test ($p < 0.001$). Of these, 30 students showed a significant increase in ability ($p < 0.05$). Ten questions showed a significant change in difficulty level.

Conclusions: Students learned the material over the semester as indicated by the overall increase in student ability. Changes in question difficulty provide evidence for the importance of practice when learning concepts.

Keywords: Multiple choice examination; Test assessment; Student learning; Course design; Concept theory

Introduction

Research methods have been identified as important topics to cover within pharmacy education. Both the Center for the Advancement of Pharmacy Education (CAPE) educational outcomes and the Accreditation Council for Pharmacy Education (ACPE) Accreditation standards and guidelines have listed the ability to critically evaluate research literature (including research design, biostatistics, and methodology) as one of the fundamental skills for student pharmacists.[1,2] Knowledge of research methods and design is vital for critically evaluating published literature and for conducting future research through a student research project, a residency project, or other research opportunities.

Concepts are cognitive tools that organize information about objects, symbols, or events into categories.[3–7] When an object, symbol, or event is identified as belonging to a specific category, the characteristics associated with that concept become instantly available. For example, individuals who know the basic research design concepts of a randomized-controlled trial (RCT) can differentiate a RCT from other study designs based on the design characteristics. Specifically, a RCT is characterized by the use of random assignment of subjects to study groups. If the study abstract states that subjects were assigned to treatment groups using randomization, readers know that the study design is a RCT and can instantly access the knowledge they have related to RCTs. If readers know that a RCT is the gold standard of comparative study designs and if study procedures were operationalized correctly, then they know that the primary threat to internal validity involves dropout or withdrawals after the study begins. The reader would also

This project evaluation received a grant from the University of Arizona Graduate and Professional Student Council research award in order to purchase statistical analysis software for this project.

* Corresponding author: Jill M. Augustine, PharmD, MPH, University of Arizona College of Pharmacy, 1295 N. Martin Ave, Tucson, AZ 85721.

E-mail: jaugustine@pharmacy.arizona.edu

http://dx.doi.org/10.1016/j.cptl.2015.08.006

1877-1297/

know that at least two comparison groups should be treated in a parallel manner and that the most commonly used tests for statistical analysis are a *t*-test or a Chi-square test.

Use of concept theory to develop instruction and related assessments was described by Merrill and Tennyson[4] and applications to chemistry,[5] a science, technology, engineering, and mathematics (STEM) course,[6] and pharmacy education[7] have been described. Because the basic task in concept classification is to categorize an example as belonging to a specific category, the instructional strategy for teaching concepts involves using examples of the concept and non-examples (examples from related categories). Learning is facilitated if the characteristics of examples are explicitly described and differentiated from non-examples. A range of examples from typical examples to non-examples and practice categorizing examples also facilitate learning. Exams to test classification include examples for the student to categorize; however, the examples must be new to the student. If the example is not new, then the tests recall rather than concept classification.

The difficulty of classifying examples depends on the characteristics of the example. If the examples are simple and concrete (e.g., apples and oranges), then examples are easy to classify. If the examples are abstract and complex (e.g., a report of a study involving multiple treatment arms and complicated statistics) then the examples can be very difficult to classify.

Concept theory has been used as a basis of instruction and testing in our research methods course for a number of years. However, no evaluations have been conducted to verify that this approach actually produced significant learning. Therefore, we undertook a program evaluation using a pre-test and a post-test to assess concept learning during the course. The pre-test would document entry-level skills and the post-test would indicate if students were indeed learning from course instruction. Additionally, we wanted to identify which topics were most difficult.

Methods

Participants

The test was administered to second professional year Doctor of Pharmacy (PharmD) students enrolled at the University of Arizona College of Pharmacy at the beginning and the end of their required research methods course during the fall semester of 2013. At this four-year public college of pharmacy, the students received no formal courses or classes on research method topics before this course. The class enrollment was 97 students. Based on class enrollment information, 58% ($n = 57$) of this class is female, the average age is 24 years (range: 19–52), and 46% ($n = 46$) of students have a bachelor's degree.

Course design

At this university, the research methods course is the second of three course-series PharmD. students are required to complete. The first course focused on biostatistics and the third involves literature evaluation. The basic instructional strategy used in the research design course was to present an example research design using a study report, identify the relevant characteristics of the design, and demonstrate where information on relevant characteristics can be located in the report. Included with the discussion of each study design were subordinate concepts related to statistics (i.e., identifying the statistical test used), types of variables (e.g., identifying the independent and dependent variables), and validity issues (e.g., identifying the primary threat to internal validity). Practice in classification was provided through the use of homework consisting of abstracts followed by five to ten associated multiple choice questions requiring concept classification.

Instrument

The testing instrument was developed using abstracts from published literature. The abstracts were selected based on their study design and if the research question was applicable to pharmacy. These abstracts have been used in this course with previous examinations and have been deemed by course faculty members to contain essential details of research methodology. The first abstract described a pre–post intervention that utilized patient education and pharmaceutical medication to reduce cardiac risk in diabetic patients.[8] The second abstract described a randomized, controlled trial for a new medication to reduce stroke risk.[9] Using selected abstracts and results tables, 25 concept-based questions were developed. Each question was used to test a research methods concept (e.g., study design, validity, or types of variables). Study designs represented in the abstracts selected included: (1) pre-test and post-test (15 questions); and (2) randomized-controlled trial (seven questions). The last three questions addressed questionnaire research. The abstracts and questions reflected overall course content. Not all course topics were covered in this test. The same questions (i.e., an identical test) were used for the pre- and post-tests.

Data collection

On the first day of the course, students were invited to complete the pre-test. On the last day of the course, students were invited to complete the post-test. Students were not given the opportunity to study for either of the tests. Pre-test and post-test grades were not calculated or applied to the students' overall course grade. The instructors did not review the questions with students after the pre-test. Students were given 30 minutes during class to answer questions and to enter their responses on a Scantron® form. Students were assigned a three-digit code when they returned the consent form and pre-test so that their pre- and post-test responses could be linked. Each student was asked to read, sign, and return the cover page in order to get