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Utilizing desirable difficulties for sterile compounding training in a skills-based laboratory course

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ABSTRACT

Background and purpose: Sterile compounding skills are essential components of a professional pharmacy curriculum. The theory of desirable difficulties has been used to facilitate deeper learning of material in other disciplines, but has not been described in pharmacy sterile compounding instruction. The purpose of this work was to evaluate whether challenges introduced in sterile compounding would act as desirable difficulties and result in greater student confidence in their sterile compounding competency.

Educational activity and setting: Students in the fourth semester of *Pharmacy Skills and Applications*, a laboratory-based skills course, were presented with challenges in sterile compounding and were asked to complete a questionnaire rating their confidence and describing their experience.

Findings: The majority (92.8%) of students reported that the activity increased their confidence in their sterile compounding skills. Students' open-ended responses suggested that most of the knowledge gained was strategic in nature.

Discussion: The results of this activity met the instructors' initial goals by positively impacting students' confidence in their ability to overcome challenges with sterile products compounding. Course instructors may explore additional skills in which to introduce desirable difficulties in order to build student confidence.

Summary: Course instructors were pleased with the implementation and results of this desirable difficulties activity and plan to continue its use again in future semesters. Incorporating more real-world challenges throughout the skills-lab course may be beneficial to student learning and confidence. With thoughtful planning, faculty at other institutions can readily incorporate similar activities within their own courses.

Background and purpose

Sterile compounding competence is an important part of the pharmacy school curriculum. In 2012, the American Association of Colleges of Pharmacy recommended increasing the resources for sterile compounding instruction by proposing the dedication of three faculty members to compounding curricula, direct observation of students' skills, and quantitative analysis for assessment.[1] Historically, students at our institution have struggled with sterile compounding. Initially, it was hypothesized that additional technical practice would improve student performance, so opportunities were increased from one faculty observed practice to four

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faculty observed practices during the timeframe of one semester. Although the amount of direct observation and evaluation of student performance was increased, faculty continued to perceive that students were struggling with troubleshooting problems with sterile compounding, despite having increased technical skill. This provided the opportunity for alternative instructional techniques to be considered.

Desirable difficulties, as described by Bjork and Bjork,[2] are challenges in educational activities that create more durable student learning through triggering deeper cognitive processes that support learning, retention, and comprehension. Difficulties are only thought to be desirable if the learner possesses the background knowledge and skill to appropriately respond to the difficulty.[2] Bjork and Bjork[2] originally described desirable difficulty methods that included variations in learning conditions, spacing study sessions, using testing rather than presentations for studying, and interleaving separate topics rather than blocked practice sessions. Additionally, Alter et al.[3] connected the theory of desirable difficulties to William James' dual–process psychological theory describing "System 1" cognitive processes as being low effort, quickly executed and automatic and "System 2" cognitive processes as deliberate, slower, analytical, and requiring more reflection. Alter et al.[3] succeeded in moving subjects to System 2 cognitive processes by using desirable difficulties in a series of experiments. Moreover, Frederick[4] describes research purporting that dysfluent or degraded fonts could also serve as desirable difficulties by slowing the subject's cognitive processing and making them think more critically, activating forms of reasoning that could move subjects from System 1 to System 2 processes.[3]

The goal of this project was to explore whether planned, instructor-designed challenges introduced in sterile compounding could serve as desirable difficulties, moving students from System 1 to System 2 cognitive processes, thereby resulting in greater student confidence in their ability to perform these skills.

Educational activity and setting

Pharmacy Skills and Applications is a six-semester course series that progresses throughout the first three professional years of the pharmacy program. It consists of a one-hour weekly lecture and a two-hour weekly lab over the course of a semester (generally 15 weeks long). Sterile compounding, while introduced during the second and third semesters of this course series, is extensively applied and practiced during the fourth semester (spring of the second professional year). Students practice the skills in the lab with one-on-one faculty feedback via a sterile products checklist four times throughout the semester in preparation for a high-stakes practical examination at the end of the semester. Successful completion of the hands-on practical examination is required to pass the course by scoring greater or equal to 70% on the sterile products checklist. Students who are unsuccessful have an opportunity to remediate and receive a second attempt.

The first three practices of the Spring 2017 semester were administered as usual (no planned purposefully engineered challenges) to provide the students with baseline comfort in the sterile compounding process. During the fourth practice of the semester, students encountered one of four randomly assigned challenges during their sterile compounding practice (see Table 1). Although overcoming challenges in sterile compounding is addressed during the lecture and demonstrated by the instructor in the laboratory, not all students had the opportunity to personally experience these challenges as active learning. The challenges were designed to slow the students down and make them think critically about how to overcome their assigned difficulty. Challenges were also designed to mimic scenarios that practicing pharmacists and pharmacy technicians might face in real-world sterile compounding encounters. Students were given no additional time to account for these difficulties, but were given the option of obtaining additional supplies if requested. Within one week following completion of this fourth sterile products practice, students completed a short questionnaire and reflection regarding their reactions to the assigned challenge and how it impacted their confidence with sterile compounding. This four-item questionnaire consisted of one Likert-scale question assessing change in confidence following the practice and three open-ended questions (see Table 2). Students were given participation points for completion of this questionnaire. After all students had the opportunity to experience the fourth practice and complete the questionnaire, a debriefing was held with the entire class which explained all four challenges.

Frequencies and descriptive statistics were used to evaluate student scores and Likert scale responses. Student responses to the question of "What will you do differently in the future if or when sterile compounding challenges recur?" were evaluated qualitatively via an iterative theory-based thematic analysis.[5] Whole responses were coded in a mutually-exclusive fashion according to the type of knowledge gained (Facts, Concepts, Procedures, Strategies, and Beliefs) using a framework for types of knowledge for problem solving described by Mayer.[6] In order to strengthen our reliability, ten percent of student responses were initially categorized and achieved 80% agreement among three investigators. Based on the themes discovered in the initial process, the categories were then refined by the investigators to Internal Strategies, External Strategies, Beliefs, and Other to better fit the data. Using a non-mutually

Table 1
Types of challenges introduced during sterile compounding practice.

Challenge	Description
Defective needle	Student was given a compounding needle that was plugged with glue
Corrected reconstitution instructions	Student was given new instructions for vial reconstitution, necessitating new calculations or reconstituting a new vial
Inappropriately pressurized vial	Student was given vial of diluent that was positively pressurized by adding air to vial
Patient weight change	Student was given patient weight prior to completing calculations, then interrupted mid-compounding with a new weight necessitating new calculations