Bracketology in Pharmacy Education: The Impact of March Medication Madness on Student Engagement and Knowledge

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Abstract

Description of the Problem. Gamification is used in pharmacy education as an innovative learning strategy to engage learners with educational content. The March Medication Madness activity used bracketology, a type of gamification not previously described in pharmacy education literature, to increase student engagement and knowledge of key disease states. *The Innovation.* The activity was developed for use in a capstone course during the final semester of the didactic pharmacy curriculum. Students created medication-related pearls that were placed in a tournament-style bracket. Students then completed brackets to predict the winning pearls and voted biweekly to determine the most clinically significant pearl. Student knowledge was assessed pre- and post-activity along with a post-activity perception assessment. *Critical Analysis.* Of the 52 student participant responses, most agreed or strongly agreed that the activity increased understanding and stimulated interest in course material, while adding a fun element to the course. There was a statistically significant increase (P = .002) in the average percentage of multiple-choice questions students answered correctly from the pre-test (57.7% ± 1.5%) to the posttest (63.1% ± 1.9%). Pearls that received the most votes were no more likely to be associated with an increase in knowledge than pearls receiving fewer votes. *Next Steps.* Implementation of a bracketology activity was perceived by students as fun, engaging, and beneficial in understanding course material. However, increase in knowledge was limited. This shows the importance of structuring gamification in a way that provides educational value and underscores the need to modify the activity to promote student learning.

Keywords: gamification, bracketology, pharmacy education, game-based learning

DESCRIPTION OF THE PROBLEM

Active learning has been widely used by pharmacy educators across the nation and has been shown to increase long-term knowledge retention in pharmacy students.[1,2] This is due in part to the positive correlation between student engagement and improved academic outcomes.[3] The Accreditation Council for Pharmacy Education (ACPE) Standards 2016 identifies the use of didactic methods of instruction to "actively engage learners" as a key element in Standard 10.[4] Various gamification modalities have been implemented including trivia, gameshows, escape rooms, and puzzles.[5–7] Literature reviews evaluating the efficacy of gamification in pharmacy education have found that gamification can be a useful tool for student engagement and learning, while identifying the need for improved quality of gamification research.[8,9]

In a pharmacotherapy capstone course focused on applying knowledge to complex patient cases, students and faculty desired a way to review key concepts from various disease states. Because the course (held during the final didactic semester) was a case based, knowledge application course, it did not offer targeted disease state instruction. Thus, a bracketology activity was developed to address this need. Bracketology is a type of gamification described in medical literature as a method to increase engagement and provide continuing medical education (CME).[10,11] Bracketology is the process of forecasting or predicting the outcome of paired opponents in brackets (a type of tree diagram) through a head-to-head elimination style tournament. Each pairing results in one item advancing on to the next head-to-head matchup, while the remaining item is eliminated.[12]

NephMadness is an example of bracketology's use to expand the impact of the nephrology community's social media presence while providing free open access to medical education (FOAMed) and CME credit.[10,11] Scouting reports, which summarize key FOAMed information, are developed by topic experts and shared to the American Journal of Kidney Diseases blog. "Hot topics" in nephrology are paired against each other, and healthcare professionals are invited to complete a bracket by predicting the topic most likely to change practice in the next five years. A panel of nephrologists decides the winners based on expert opinion. Social media use is tracked to determine the impact. The number of users posting to social media (77 to 1,719) and brackets submitted (256 to 1,393) increased significantly between 2013 and 2020.[10,11]

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Bracketology has also been described as an active learning strategy in undergraduate education. Plant Madness was developed by a university horticulture department. In this activity, students selected a plant not covered in the curriculum that was placed into a bracket. On "game days," students were given two minutes to share information about their plant and were scored by graduate students or outside faculty. The highest score in each pairing advanced to the next round. A post-activity assessment of student perceptions showed that 98% of students liked the activity and 93% felt that it increased their knowledge. Actual knowledge change was not assessed.[13] However, no existing research has explored the impact of bracketology on pharmacy students' engagement or knowledge. March Medication Madness, a bracketology activity, was introduced into the pharmacy classroom setting with the aim of enhancing both student engagement and knowledge. It served as a method to review important concepts from significant disease states covered in the course.

THE INNOVATION

Activity Design

March Medication Madness was developed and implemented into a course at a Midwestern University. The process began with the creation of a 32-team bracket template using Microsoft Word (version 2404, Microsoft, Redmond, WA) as shown in Figure 1. Each of the four quadrants of the bracket was allocated a practice setting, aligning with the ACPE required Advanced Pharmacy Practice Experiences (Acute, Ambulatory, Community, and Institutional).[4] Eight faculty members involved in the course served as coaches, overseeing four teams. The coaches received a personalized information packet containing team information, sample pearls, associated multiple-choice questions, and a schedule of events. Additionally, they met virtually with the lead faculty for a brief training session and selected a topic area or disease state for their practice setting. Each practice setting or quadrant covered two disease states.

In February, the activity was introduced to students face-to-face in the classroom. All students were invited to participate in the activity. Student participation was incentivized through course credit for pearl creation, bracket completion, and engaging in round-by-round voting, but was not required. All pharmacy practice faculty were also invited to participate.

Students choosing to participate were provided with the practice settings and disease states. Then, the 67 students formed teams of two to three participants, resulting in 32 teams in total. Random assignment of teams determined their respective practice setting and topic area. Teams created two unique medication-related pearls aligned with their assigned practice settings and topic areas and two multiple-choice questions. These pearls focused on pieces of knowledge deemed valuable or fundamental to pharmacy practice, typically conveyed in two to three sentences. See Table 1 for sample pearls. Multiple-choice questions served to reinforce understanding of each pearl's content.

During March, teams collaborated with their coaches to refine and select one unique pearl and its corresponding question. Coaches held advisory roles that included ensuring the validity of the pearls and questions and requesting revisions, when appropriate. The process involved an in-person or virtual meeting and resulted in the creation of 32 distinctive pearls – eight for each practice setting with four per topic area. These finalized pearls populated the 32-item bracket and were compiled in a "scouting report" booklet. There was no direct tie to individual clinical cases in the course and pearls developed; however, there was overlap in general clinical topics covered.

Brackets with the starting pearl pairings were uploaded into the learning management system (LMS). Students were invited through the LMS to complete brackets by selecting the most clinically impactful pearls within each pairing. To ensure impartiality, the authors and coaches' identities were concealed. Additionally, discussions about the pearls' origins were discouraged before bracket completion.

The voting process to determine "winners" for each round took place biweekly over three weeks through QualtricsXM (Qualtrics, LLC, Provo, UT) surveys, allowing all participants to review the pearls and electronically cast votes for their preferred pearl within each pair. The winning pearl was determined by popular vote (i.e., voter perceptions of clinical significance) and advanced on to the next round; the losing pearl was eliminated from future consideration. Each of the five rounds of voting had between 65 and 71 votes cast (71, 67, 67, 65, and 66 votes, respectively). Updates were provided to participants, highlighting leaderboard standings and pearls advancing to subsequent rounds. The participant with the most accurate (i.e., highest-scoring) bracket and the champion pearl team were recognized with certificates.

Survey/Assessment Design

Prior to the start of the tournament and dissemination of the scouting report, the multiple-choice questions generated by teams were collated into a 32-question pre-test for participants to assess baseline knowledge. Following the tournament's conclusion, participants undertook a posttest featuring the same 32 questions from the pre-test. Three additional items gauged participant perception of the activity's value via a five-point Likert scale (ranging from 1 = *strongly disagree* to 5 = *strongly agree*) and whether the activity should be continued (yes/no). This electronically administered posttest was facilitated through QualtricsXM (Qualtrics, LLC, Provo, UT). This project was approved by the Institutional Review Board at North Dakota State University.

Statistical Analysis

Pre- and post-knowledge tests were compared using a paired samples *t*-test to determine if there was a change in student knowledge by analyzing responses for each question. Pre- to posttest differences for individual questions were evaluated using binomial sign tests. Further analysis using Pearson correlation was done to determine if the question round in the bracket correlated with posttest knowledge as well as if pre-test and posttest percentages were associated.

Quantitative outcomes were summarized using means and standard deviations, while student perception data were summarized using frequencies and percentages. All analysis was performed in R (version 4, The R Foundation, Vienna, Austria) or Microsoft Excel (version 2404, Microsoft, Redmond, WA), and the significance level was set at 5% for all inferential analysis.

Findings

Seventy-seven percent (52 out of 67) of students completed both pre- and posttests, answering at least 80% of the questions. This 80% threshold was chosen to account for potential external factors, given that two participants only missed one question each. Due to the limited number of faculty participants, only student data were included in the analysis. The activity was delivered as intended and resulted in a statistically significant, though modest, increase ($t_{51} = 3.34$, $P = .002$) in the average percentage of multiple-choice questions students answered correctly from the pre-test (57.7% ± 1.5%) to the posttest (63.1% ± 1.9%).

On individual questions, the percentage of students who correctly answered knowledge questions significantly differed from pre- to posttest on three pearls that did not win any rounds of voting (50.0% vs. 94.2%, $P < .001$; 38.5% vs. 59.6%, $P = .035$; and 38.5% vs. 61.5%, $P = .002$, respectively). There was a statistically significant decrease in knowledge on one question (46.2% vs. 21.2%, $P = .004$). Pearls that won one or two rounds did not yield any statistically significant pre- to posttest differences. A statistically significant decrease in pre- to posttest knowledge was found in one pearl that won three rounds (53.8% vs. 32.7%, $P = .003$). One pearl that won four rounds showed a statistically significant pre- to posttest improvement (40.4% vs. 80.8%, $P < .001$). The "champion" pearl did not show a statistically significant change on the pre- to posttest knowledge assessment (63.5% vs. 65.4%, $P = 1.00$). The percentage of students who answered a question correctly on the pre-test was positively correlated with the percentage of students who answered correctly posttest ($r = .807$, $P < .001$). Overall, the number of rounds won in tournament was not significantly correlated with percentage of students who answered questions correctly on the pre-test ($r = .011$, $P = .95$), percentage of students who answered questions correctly on posttest ($r = .005$, $P = .98$), or the difference in percentages between the pre-test and posttest ($r = -.01$, $P = .96$).

Following the activity, 46 out of 58 (79.3%) students agreed or strongly agreed that the March Medication Madness activity increased their understanding of the course material, 44 (75.9%) agreed or strongly agreed that the activity stimulated their interest in course material, and 51 (87.9%) agreed or strongly agreed that they had fun during the activity. Most students (98.3%) agreed that the activity should be used in subsequent semesters.

CRITICAL ANALYSIS

Results of this project indicated that the March Medication Madness activity was fun and engaging, based on Likert scale responses. Students felt strongly that the activity aided in their understanding of course material; however, this was not consistently supported by the change in pre- to posttest scores. Similar outcomes have been shown with other gamification activities with generally favorable increases in engagement yet little to no increase in knowledge, despite student perception of knowledge increase.[8,9,14,15] This adds to the body of literature supporting the need for gamification activities to not only be engaging but also be structured in a way that increases knowledge. Instructors cannot assume their students are learning simply because students enjoy an activity or claim their knowledge increased.

In March Medication Madness, the number of rounds won by a pearl did not consistently align with improved posttest scores, which was potentially influenced by several factors. Many pearls exceeded the suggested length of three sentences, potentially decreasing student motivation to engage deeply for enhanced knowledge retention. Continued material review could be encouraged through methods like discussion boards or debates as seen in Plant Madness.[13] Not all pre- and posttest questions aligned with pearls' information, necessitating external knowledge integration. Future attention should focus on pearl and assessment question formatting and validation. Additionally, incorporating a control group could clarify the activity's impact on learning, since variables like external coursework and topic exposure might have affected pre- and posttest scores. Finally, students' ability to discern clinical significance might be limited at this training stage. Further research should explore student involvement in voting, drawing from NephMadness' expert-driven model that contrasts with our participant-based approach.[10,11]

NEXT STEPS

Implementation of a bracketology activity into the curriculum was reported by students as fun and aiding in their understanding of course material. However, an increase in knowledge was limited and not correlated with pearl progression within the tournament. This shows the importance of structuring gamification in a way that provides educational value and reinforces the need to make modifications to the activity for future iterations to promote student learning.

Conflicts of Interest: None.

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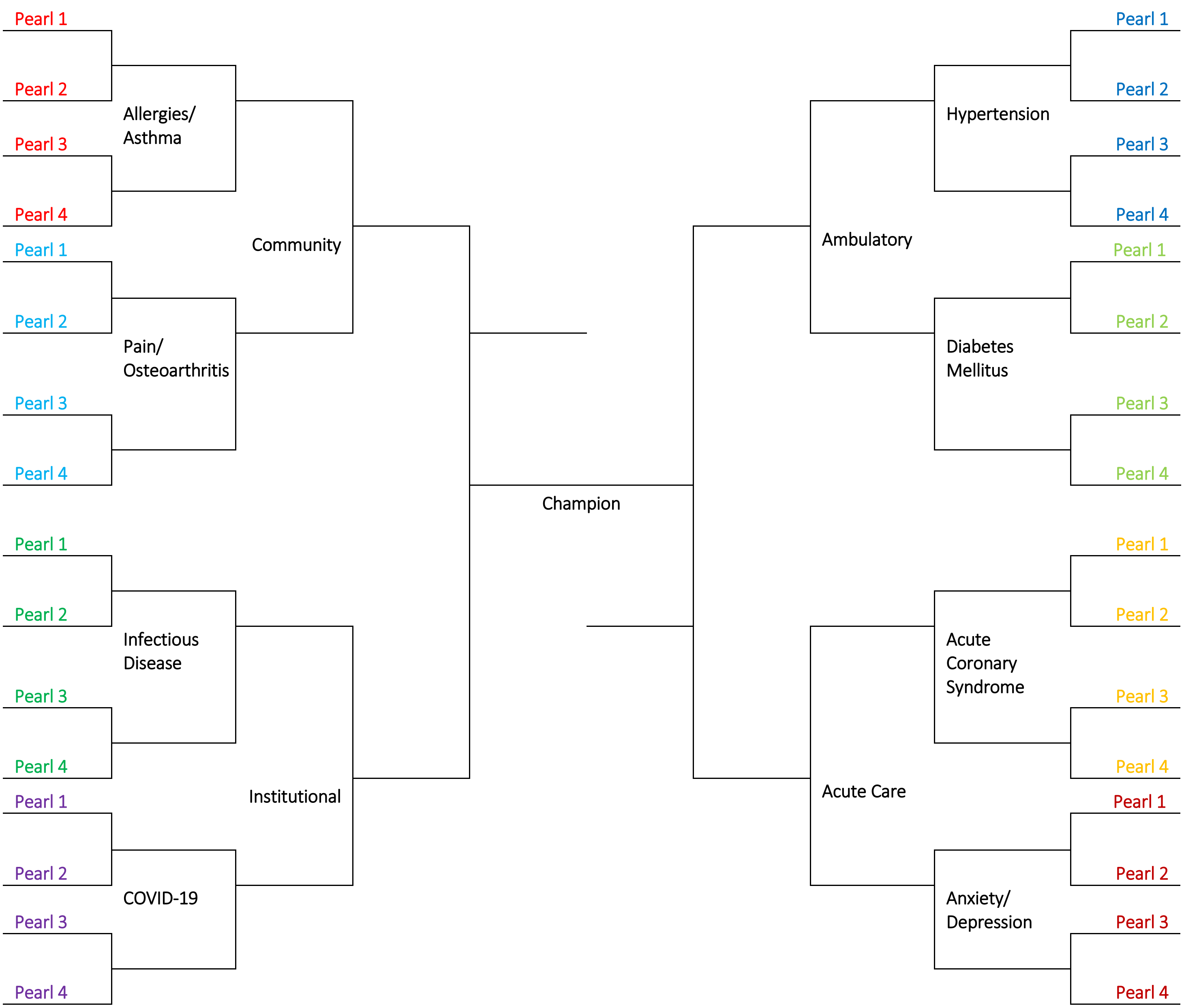
Figure 1. Bracket template



Each color font represents a different disease state or topic. Ex. The purple pearls correspond to COVID-19. The four practice settings listed encompass two disease states and eight corresponding pearls. For example, the institutional setting includes the topics of infectious disease and COVID-19 along with the pearls listed in dark green and purple.

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Table 1. Sample pearls created by students included in the scouting report. Directions given to students to aid in creation of pearls included "highlight a medication related item that you feel is important for others to know and not routine knowledge."

Practice Setting	Disease State	Pearl
Acute	Anxiety and/or Depression	Treatment-resistant depression is when a patient has an inadequate response to two or more antidepressant trials from separate classes within 4-6 weeks after target dose has been reached. There is no one treatment that is used to treat refractory depression. The mnemonic SACO has been used to help with approaching the next treatment steps. In no particular order, it stands for Switching therapies, Augmentation, Combination of antidepressant classes and Optimization, as appropriate approaches for managing treatment-resistant depression.
Ambulatory	Hypertension	Beta blockers are a common class of medication prescribed for the treatment of hypertension. Two medications in this class, labetalol and carvedilol, also have additional alpha blockage. The combined beta and alpha blockage seen with these drugs have several benefits compared to drugs with only beta blockage. Some benefits include increasing blood flow to the tissue, reducing pressor response induced by beta blockage in patients with low renin, improves urine flow in patients with prostate disorders, improves sexual function, and overall improves circulation in patients with congestive heart failure.
Community	Osteoarthritis and/or pain	Topical Capsaicin is not recommended for osteoarthritis of the hand or hip. Topical Capsaicin should not be used for osteoarthritis of the hand due to potential of transmitting the medication into your eyes. Topical Capsaicin should not be used for osteoarthritis of the hip due to the depth of the hip joint and will likely not having a meaningful therapeutic effect.
Institutional	Infectious Disease	Up to 90% of penicillin allergies can be removed from a patient's chart. Many individuals who report a childhood reaction from penicillin have since outgrown the allergy or were never allergic at all. Patients that report anaphylaxis, DRESS syndrome, or desquamative rashes should NOT be considered for penicillin treatment, as those adverse reactions are serious. To be sure about a patient's penicillin allergy, patients can get penicillin skin testing! This tool may be useful in a situation where penicillin would be the best choice for treating the patient's current condition.

Abbreviation: DRESS, Drug reaction with eosinophilia and systemic symptoms

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