

INSTRUCTIONAL DESIGN AND ASSESSMENT

Using Cooperative Learning for a Drug Information Assignment

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Objectives. To implement a cooperative learning activity to engage students in analyzing tertiary drug information resources in a literature evaluation course.

Design. The class was divided into 4 sections to form expert groups and each group researched a different set of references using the jigsaw technique. Each member of each expert group was reassigned to a jigsaw group so that each new group was composed of 4 students from 4 different expert groups. The jigsaw groups met to discuss search strategies and rate the usefulness of the references. In addition to group-based learning, teaching methods included students' writing an independent research paper to enhance their abilities to search and analyze drug information resources.

Assessment. The assignment and final course grades improved after implementation of the activity. Students agreed that class discussions were a useful learning experience and 75% (77/102) said they would use the drug information references for other courses.

Conclusion. The jigsaw technique was successful in engaging students in cooperative learning to improve critical thinking skills regarding drug information.

Keywords: active teaching, cooperative learning, jigsaw technique, drug information

INTRODUCTION

As healthcare professionals, pharmacists are often decision makers in settings ranging from patient care to managed care and often consult the literature to determine, for example, current practice guidelines or drug interactions or dosing. Information literacy and applied literature evaluation are fundamental components of the doctor of pharmacy (PharmD) curriculum.¹ Students should be capable of conducting systematic searches using medical or health references to formulate responses to drug information questions. The curriculum should aim to instill students with the ability to critically analyze information and apply knowledge to novel scenarios.

A cooperative learning activity was incorporated into a required 2-credit Biomedical Literature Evaluation course offered in the second year of the PharmD curriculum at the Philadelphia College of Pharmacy. The assignment introduced students to 47 tertiary drug information references that are relevant to modern pharmacy practice. Searching all of these references would be a daunting task for an individual student, thus, a cooperative learning approach was taken.

Cooperative learning most often involves small groups of students who contribute to each other's learning.² Student interactions lead to opportunities for improving communication skills, and more importantly, to collective problem-solving.^{3,4} One cooperative learning tool is the jigsaw technique which involves dividing up parts of the assignment or problem (jigsaw pieces), and then assigning groups of students to become "specialists" in one area of the problem.⁴ Students learn the new material in order to assume the role of "knowledge expert," then teach their new-found knowledge to peers in their group. The original groups dissolve but individual members merge into a new heterogeneous groups working together to solve different parts of the puzzle and view the "big picture."

The jigsaw method has been used in other disciplines and has also been used at the elementary, high school, and higher education levels.^{3,5} Including active-learning activities such as the jigsaw technique in the pharmacy curriculum can foster life-long learning and development of critical-thinking skills.⁶ Cooperative learning activities described in the pharmacy education literature include peer teaching and facilitated group discussions.^{7,8} These activities enhances students' confidence, knowledge, and ability to apply information.

This paper describes how the jigsaw technique was used to engage small groups in a large classroom setting. The purpose of the activity was to promote analytical thinking skills surrounding the use of tertiary drug information

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references. A learner-centered teaching approach engaged students in using discipline-specific resources found in real practice, and also permitted repetitious application of skills in assignments later in the semester.⁹

DESIGN

One of the objectives of the Biomedical Literature Evaluation course was for students to demonstrate skills in identifying, collecting, and evaluating information from tertiary biomedical literature. *Drug Information: A Guide for Pharmacists* was a required textbook and assigned readings provided direction on using a modified systematic approach to answer a question.¹⁰ In order for students to select the most appropriate and relevant references to answer drug questions, they had to have a fundamental understanding of what content was and was not included in references. The instructional methods for the course were redesigned to enhance students' fundamental knowledge of reference content through independent research before class and group discussions during class. This fostered development of problem-solving and critical-thinking skills, as well as communication skills.³ Students also gained knowledge of technology when accessing electronic resources through the university library's Internet-based services.

Faculty members from the Department of Pharmacy Practice and Administration, and Information Science taught the course. The course coordinator was responsible for designing and grading assignments and activities. A 45-minute lecture on tertiary information resources was delivered by an Information Science faculty member during week 2. Following the lecture, students engaged in a 5-minute pair-and-share activity to identify the best reference to answer a drug information question. The students then were assigned to write a 3-page research paper answering drug information questions.

In fall 2003, an additional 50-minute class period was dedicated to a new cooperative learning activity during week 5. The activity was evaluated by the director of the University's Teaching and Learning Center during the first implementation. During the first week of class, students were asked to identify a therapeutic area of interest that arose from their school, work, or family experiences so that their drug information assignments could be

matched to their interest area (Table 1). The students formed cooperative learning groups for this activity only.

The first major step in the jigsaw activity was to "separate the jigsaw puzzle pieces" into expert groups (Figure 1), and allow students to work individually to research a set of drug information questions using 4 assigned drug information references (Table 2).⁴ The entire class was divided in 4 sections of 26 to 32 students to form the expert groups. The students had 3 weeks to complete the paper based on their assigned drug/disease topic and to utilize their assigned references based on their expert group assignment. The students were required to cite at least 2 references per question and a minimum of 7 references for the entire paper. They could use a reference more than once. The grading criteria for the written paper stated the assignment expectations for avoiding plagiarism, formatting the paper, developing responses with sufficient depth, and using correct spelling and grammar (Table 3).

A search strategy tool was given to students to assist them when researching their drug information questions independently (Table 4). The students could record notes on their search methods for each reference source, ie, search by generic drug name or product imprint code. The tool included categories reflecting the scope of the resource such as "included details on adverse reactions, drug interactions, and pictures of dosage forms," or "included references to primary or tertiary literature."

The second major step "brought the jigsaw puzzle pieces back together" through formation of 4-member jigsaw groups. The course coordinator created jigsaw groups composed of 1 member from each of the expert groups and 2 to 3 other students randomly selected from the remaining class members. Each of the jigsaw groups had a common drug and disease/condition, ie, levofloxacin and bronchitis, to discuss. During week 5, when the jigsaw groups met, each group was prepared to discuss a total of 16 references (Table 2).

A drug information reference grid was created that listed categories that described the scope of the reference (grid is available from the author by request). The categories were similar to those listed in the search strategy tool (Table 5). During the class, each expert member of each group discussed the usefulness of his/her 4 references

Table 1. Steps to Implementing a Jigsaw Exercise in a Large Pharmacy Class

Ask students to identify a therapeutic area of interest during the first week of class.
Prepare a list of 4 expert groups; each expert group is assigned a set of 4 drug information references.
Prepare a list of jigsaw groups containing 4 students per group; composed of 1 member from each of the expert groups.
Develop a list of drug information questions.
Create a search strategy tool to document search methods for each reference.
Develop a drug information reference grid that lists categories that describe the scope of the references.
Develop a list of questions describing clinical scenarios for wrap-up discussion.

Jigsaw Technique

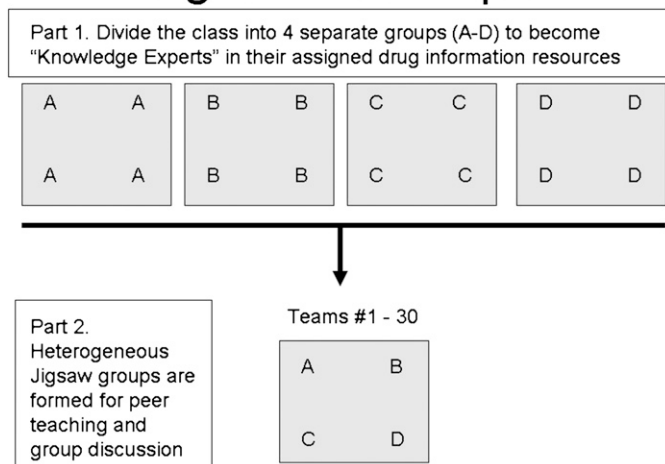


Figure 1. Jigsaw Technique.

and utilized a Likert scale to rate the reference. The scale was: 0 = would not use this reference; 1 = has some information, but not the best source; 2 = best reference to use for this information. One student in each group, the recorder, documented each student's ratings on a drug information reference grid. To promote effective group work, students were encouraged to assign roles such as the recorder (records answers on reference grid), timekeeper, tie-breaker (decision maker), and presenter (to begin the group's presentation to the class).¹¹ The research paper grade was based on the individual students' contribution,

Table 2. Expert Group Assignments in a Biomedical Literature Evaluation Course

Expert Group A
American Hospital Formulary Service Drug Information Physicians' Desk Reference
Davies's Textbook of Adverse Drug Reactions
Drug Topics Red Book
Expert Group B
Mosby's Drug Consult
Martindale: The Complete Drug Reference
Drug Interactions: Analysis and Management
Micromedex
Expert Group C
Drug Information Handbook
STAT!REF: USP DI for the Healthcare provider
Drug Interaction Facts
Drug Topics Red Book
Expert Group D
Facts and Comparisons
USP DI Advice for the Patient
Evaluations of Drug Interactions
Micromedex

USP DI references were no longer published after 2008

whereas points contributing to the overall course grade were awarded to each individual student when the jigsaw group submitted a completed grid.

To apply the information to a clinical scenario, the jigsaw groups were given questions reflecting practical problems and had to generate a list of drug information resources that would be best suited to answer the question. The recorder was responsible for documenting their answers on a worksheet.

Because of the large class size (100 to 125 students) and fixed seating in the lecture hall, group members sat in adjacent seats for the activity to facilitate interaction and discussion. One faculty member circulated among the groups to ensure that the students stayed on task. The faculty member led the entire class in a final open discussion on locating information on drug costs, therapeutic drug concentrations, and identification of dosage forms. The overall message to students emphasized that multiple resources may be needed to answer drug information questions, and that pharmacists are expected to search a variety of references.

EVALUATION AND ASSESSMENT

In order to evaluate the course from fall 2002 to spring 2006, the semesters were organized into 3 phases (Table 6). The jigsaw activity was implemented in fall 2003. Table 6 lists the drug information paper and the point assignment for the completed drug reference grid. The grade distributions were not normally distributed so the data are reported as the median and the first and third quartile. The letter grade assignments were based on the following scale: A: 90-100, B: 80-89, C: 70-79, D: 60-69, and F: < 60. The percent contribution of these assignments to the total course grade changed slightly for some semesters. In addition, grades for the clinical trial critique paper and the final course grade were added to illustrate performance throughout the semester.

In the fall 2002 semester, 87 papers were submitted. The mean number of references cited was 10.2 (95% CI = 9.5-10.9), and ranged from 4 to 18 citations. Thirty-two (37%) students cited an adverse drug reaction reference, and 59 (68%) cited a drug interaction reference in their reference list. One hundred two papers from spring 2006 also were evaluated. The mean number of citations referenced per paper was 7 (ranging from 6 to 8).

For phase 1 (fall 2002) of the study, the drug information paper grade was based on the individual students' paper alone and was worth 15% of the total course grade. Points were assigned when the groups submitted a completed drug reference grid for phase 2 but not for Phase 3.

The instructor provided formative assessment on the students' papers using specific grading criteria and

Table 3. Grading Criteria for Drug Information Paper Submitted in a Biomedical Literature Evaluation Course

Plagiarism or cheating (loss of up to 100% of grade)
<ul style="list-style-type: none">• Responses are copied word-for-word from references, or from another students assignment, or from another reference source• Statements in response do not match reference citation
Structure of paper does not follow assigned format (total of 50% of grade)
<ul style="list-style-type: none">• Student identification, titles, questions are not listed• Paragraph format must be used for all responses to questions• Reference citations must follow format found in syllabus• References must be cited numerically in order of appearance in text
Depth of response and search results inadequate (total of 50% of grade) ^a
<ul style="list-style-type: none">• Each response must use at least 2 references• Reference page must contain 7 or more references listed for entire project• If no information is found for any given question, student makes a note of this in the answer and provides a citation for the references that were searched
Spelling or grammatical errors (loss of up to 25% of grade)
<ul style="list-style-type: none">• errors occur throughout the assignment

^aThis part of the assignment was worth 13% of the grade for fall 2002 (Phase I).

individualized written feedback. There were some trends in the individualized feedback that illustrate some problem areas. For fall 2002, 6% (5/87) of the papers lacked detail in their adverse reaction responses due to short, vague responses. The assignment asked for students to “describe 5 adverse reactions.” The majority of students provided lengthy, descriptive answers. However, many did not adequately describe the severity of the reaction (85%; 74/87) or frequency (56%; 49/87). The instructions were revised and directed students to describe any information on frequency or severity of reactions. For fall 2005, the number of comments made regarding the lack of detail concerning adverse reactions decreased (18%; 21/119). For spring 2006, 15% (15/99) of the papers lacked detail, but fewer failed to include statements about severity (24%; 24/99) or frequency (24%; 24/99) compared to fall 2005.

At the end of each semester, students completed a standard course evaluation form. The questions in the form were not specifically designed to assess the individual or group-based drug information assignment. However, students’ responses on 4 global statements are relevant to the

assessment of the activity and are listed in Table 7. For fall 2002, the mean scores reflect the students’ perceptions of class activities were in the neutral range. For the other semesters, students agreed that class discussions were a useful learning experience and participation was maximized.

DISCUSSION

The jigsaw technique was used to engage pharmacy students in an activity that would support higher-level thinking about the process for evaluating and systematically searching tertiary references. After assignments were evaluated by the faculty member and returned, students had a drug information reference grid that could serve as a useful tool for future searches and serve as a guideline when acquiring text for their own library. Although the assignment grades improved after implementation of the jigsaw activity, the assessment was limited in that it was done retrospectively and not all of the students’ papers were available for review. Over the following semesters, the assignment instructions were modified to state definitive expectations on the depth of the responses to drug questions, and the

Table 4. Drug Information Questions Used as Part of a Class Activity in a Biomedical Literature Evaluation Course

What is the brand name and manufacturer?
What is the AHFS Classification number?
Describe up to 2 dosage forms that are available (tablet, capsule, etc).
List the imprint code for the smallest dosage form.
Describe the indications for use: describe 1 FDA approved indications and/or describe 1 non-FDA approved indications.
Describe 1 common adverse reaction and 1 serious adverse reaction.
Describe 1 drug-drug interaction.
Describe the effect of the interaction, the onset, the duration and severity of the interaction.
What is the average wholesale price of the usual adult daily dose for your assigned disease state?
Phone number of the manufacturer?

Table 5. Search Strategy Tool Used in a Biomedical Literature Evaluation Course

1. Can you search by... (circle all that apply)
generic name
brand name
drug class
classification system
product imprint
manufacturer
adverse reaction
2. Scope of the reference (circle all that apply)
monograph format
dosing information
adverse reactions
drug interactions
poison/toxicology information
disease state
product tables
product pictures
references to primary literature
manufacturer contact information
cost

type and number of references that were required. Also, a frequently-asked-questions page was added to provide support for adhering to scientific writing conventions.

In classes of more than 100 students, there may be time and space limitations for the faculty member conducting small group discussions. The jigsaw activity was implemented in the regularly scheduled classroom time period, and the groups had structured activities to keep them on task. In addition, the faculty member circulated around the classroom to observe the groups and the group assignments were collected and reviewed for completeness. The entire activity required a lot of faculty preparation time, but the class time allotted was sufficient to engage students in discussion.

The assignment also had a positive effect on student workload. By assigning students a finite set of references, they were able to meet with their jigsaw group to rate the usefulness of 16 tertiary references. However, they were still free to use additional references in researching information for writing their paper. Surprisingly, for spring 2006, only 10/99 (10%) students cited a specialty adverse reaction or drug interaction reference in their paper. These references were available in print in the library but were not available electronically on the library Web site. This likely reflects that students prefer the ease of electronic access to reference texts. Ultimately, redesigning the instructions improved the consistency in number of references that students used, but their choice of references did not have a negative effect on the median assignment grade.

The activity had an impact on student performance during the immediate semester and may contribute to long-term retention of systematic searching skills. In order to create an authentic cooperative learning environment, the groups should have been structured for interdependence.⁴ This structure would hold students accountable for peer teaching and motivate them to participate in the process. This can be done by assessing the individual students' work but determining their grade by the group performance.³ This could have been implemented by replacing the wrap-up discussion with a quiz. Then, an average of the 4-member jigsaw group's quiz grade would have determined individual students' grades.

When asked about this type of activity, 75% (77/102) of responders indicated that they would use these references for other courses. Another way to assess long-term learning could involve a questionnaire to determine the type of references used at work or for other courses. For faculty members considering this type of activity in the future, a repeat assignment is recommended to give students a second opportunity to practice these skills. A peer

Table 6. Comparisons of Assignment and Course Numerical Grades

	Fall 2002	Fall 2003	Fall 2004	Fall 2005	Spring 2006
	Phase 1	Phase 2			Phase 3
Enrollment	128	118	108	119	105
Grade on DI assignment, median (interquartile range)	86.7 (80-93.3)	96.0 (92-100)	100 (97.5-100)	97.5 (95-100)	96.6 (93.3-100)
% of total grade	15	15	15	20	15
Jigsaw grid used?	No ^b	Yes	Yes	Yes	Yes
% of course grade		5	5	No points assigned	No points assigned
Grade on clinical trial critique, median (interquartile range)	91.6 (86.6-95)	95 (85-100)	— ^a	92 (87-96)	87.5 (80-92.5)
% of course grade	30	20	— ^a	25	20
Course grade, median (interquartile range)	88 (85-91)	93 (91-96)	88 (83-92)	92 (88-93)	96.6 (93.3-100)

^a Assignment not given therefore no data to report

Table 7. Student Evaluations of a Biomedical Literature Evaluation Course^a

Item	Fall 2002	Fall 2003	Fall 2004	Fall 2005
Overall, this required me to actively think about and understand the course material	3.4	2.8	-	-
The instructor emphasized the importance of understanding the material rather than just memorizing it	3.4	2.1	-	-
Other class assignments were beneficial	3.5	2.9	-	-
Class discussions were a useful learning experience	-	-	2.8	2.3
Class discussions allowed maximum student participation	-	-	2.8	2.3

^a Mean scores are presented where student responses are based on a Likert scale: 1 = strongly agree, 2 = agree, 3 = undecided/neutral, 4 = disagree, 5 = strongly agree.

evaluation tool would be useful to assess participation and communication skills.

The jigsaw technique could be applicable to other pharmacy courses to facilitate problem-solving skills. It could be utilized in a literature evaluation activity where the expert groups are assigned a specific statistical test. Each expert must develop a rationale to support or argue against the use of that test in analyzing a clinical study. This method could also be used for solving a clinical problem where multiple drug therapies exist. For example, each expert could be assigned a different antibiotic or drug class and discuss the rationale for selecting that agent in the treatment of an infectious disease problem.

If implementing this assignment in a course, 20% of the total course points are a reasonable weight for the written drug information assignment. Students were able to meet the expectations by adhering to the assignment grading criteria and achieved very good to excellent grades. To maintain organization in the classroom, the director of the Teaching and Learning Center at the University observed the first session and suggested creating team folders to facilitate rapid collection and organization of the assignments (grids, research papers, searching tools).

SUMMARY

The jigsaw technique, a cooperative learning approach, was used to engage students in a Biomedical Literature Evaluation course. Each jigsaw group member was responsible for learning about the characteristics of a set of drug information references. This was facilitated by researching and writing a drug information paper based on a specific drug and therapeutic indication. Prior to implementation of the jigsaw activity, students received formative feedback on their graded papers. However, the jigsaw activity also allowed students to engage in peer teaching. As part of the discussions, they rated the usefulness of each reference using a Likert scale, and then compared the gaps and overlaps in content. The learning methods included writing a research paper and coopera-

tive learning to enhance the student's abilities to search and analyze drug information resources.

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Appendix 1. Tertiary References for Pharmacy Practice

Print references(P)

1. American Hospital Formulary Service Drug Information (AHFS)
2. Physicians' Desk Reference (PDR)
3. Drug Information Handbook (Lexi-Comp)
4. Facts and Comparisons (loose-leaf or annual vol.)
5. Mosby's Drug Consult
6. Martindale: The Complete Drug Reference
7. USP DI (Drug Information) Volume 1,2,3*

Electronic reference (E)

8. Goodman and Gilman's The Pharmacological Basis of Therapeutics
9. E*Facts: Drug Facts and Comparisons
10. Lexi-Comp: Lexi-Drugs Online
11. Micromedex: Drugdex Evaluations
12. Micromedex: PDR
13. STAT!REF: AHFS Drug information
14. STAT!REF: Mosby's Drug Consult
15. STAT!REF: USP DI Professional and Patient
16. STAT!REF: USP DI Advice for Healthcare Professional

Drug Interactions and Adverse Reactions

17. Davies's Textbook of Adverse Drug Reactions (P)
18. Drug Interactions: Analysis and Management (Hansten PD, Facts and Comparisons, loose-leaf) (P)
19. Drug Interaction Facts (Facts and Comparisons, loose-leaf) (P)
20. Evaluations of Drug Interactions (EDI) (loose-leaf) (P)
21. Lexi-comp: Lexi-Interact (E)

Online reference for dosage form identification

22. E*Facts: Drug Interaction Facts
23. Lexi-comp: Drug ID (E)
24. Micromedex: Identidex Imprint Codes (E)
25. Micromedex: DrugDex Trade name (E)

Cost and Manufacturer Information

26. Drug Topics Red Book
27. Stat!Ref: Mosby's Drug Consult (E)

Over-the-Counter Products

28. Handbook of Nonprescription Drugs (APHA)

Diseases and Conditions

29. Merck Manual of Diagnosis and Therapy

Drug Dosing/Renal Dosing

30. Drug Prescribing in Renal Failure: dosing guidelines for adults. Bennett WM.

Pharmacotherapeutics

31. Applied Therapeutics-Clinical Use of Drugs. Koda-Kimble MA.
32. Pharmacotherapy: A Pathophysiologic Approach. DiPiro JT, Talbert RL, Yee GC, Matzke GR, Wells BG, Posey LM.

Compatibility/Admixtures

33. Handbook on Injectable Drugs. Trissel LA.

Special Populations: Geriatric References

34. Geriatric Dosage Handbook

Special Populations: Pediatrics

35. Harriet Lane Handbook: a manual for pediatric house officers

36. Pediatric Dosage Handbook (Lexi-Comp)

37. Handbook of Pediatric Drug Therapy (Springhouse Corp)

Pregnancy/Lactation

38. Drugs used in Pregnancy and Lactation: a reference guide to fetal and neonatal risk.
Briggs GG, Freeman RK, Yaffe SJ.

Natural Products and Nutrition

39. Micromedex: AltMed Dex Evaluations (E)

40. Natural Medicines Comprehensive database (E)

41. The Review of Natural Products (E* Drug Facts and Comparisons)

42. PDR for Herbal Medicines

43. Nutrition Facts Desk Reference

Infectious Disease

44. Sanford Guide to Antimicrobial Therapy

International Drugs

45. Micromedex: Martindale- the complete drug reference (E)

46. Micromedex: Index Nominum (E)

Calculations

47. Lexi-comp: Lexi-calc (E)

* Publication of the USP DI was discontinued in 2008.