

Innovative Team-Learning Project for Undergraduate Pathology Education

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Abstract

At the University of Minnesota, Twin Cities Campus, we have completed our seventh year of an innovative small group learning activity in an undergraduate medical school course. The purpose of the Independent Study Project has been to expose students to the process of making a pathologic diagnosis in a team-based learning format. In the Independent Study Project groups of 3 or 4 students work together to determine a diagnosis on an assigned unknown case, and then compose a 3- to 5-page paper focusing on the disease entity and the basic science underlying the disease. This project emphasizes team-based learning and illustrates the relationship and integration of pathology with clinical medicine. Professionalism is also emphasized with students evaluating and providing feedback to fellow group members. Over time, the format has become more web based with all of the cases available online with digitally scanned microscopic slides and images. Overall, the Independent Study Project has been well received by both faculty members and students.

Keywords

team-based learning, medical student education, pathology, innovative education, peer evaluation

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Introduction

Within the current culture of medicine, collaboration and cooperation is now the norm and a competent physician is characterized by being a functional and contributing member of a team. This trend is reflected in medical education with decreasing lecture time and incorporation of more team or group-based learning activities.¹ The emphasis on team-based learning can also be assimilated into undergraduate pathology medical education curricula. At the University of Minnesota, Twin Cities Campus, we have recently completed our seventh year of an innovative small group learning activity. The Independent Study Project (ISP), so named because students work independently outside of designated class time, is a team-based learning activity which takes place during the 6-week basic pathology course Principles of Pathology at the end of the first year of medical school. In the ISP, groups of 3 or 4 students are assigned an unknown case, work together to decide on a diagnosis, and then compose a 3- to 5-page paper focusing on the disease entity and the basic science underlying the disease. The

3 goals of this project are (1) to introduce students to the process of pathologic diagnosis; (2) to create a team-based activity around pathologic diagnosis; and (3) to reinforce the understanding of the science underlying human disease.

Methods

With the help of faculty in the University of Minnesota Department of Laboratory Medicine and Pathology, we have compiled a library of over 60 cases covering many organ systems

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Pathology ISP Cases

Case #	Clinical Presentation	Contact
7	12 year old girl presenting with abdominal pain, and fatigue. Imaging reveals a 8.0 x 7.5 cm right lower quadrant mass. CBC is normal. Patient undergoes exploratory laparotomy with conversion to right hemicolectomy. The mass is centered around the ileocecal valve.	Sarah Williams, MD

↓ [Hyperlink to case images and digital slide](#)

ISP Case 7

Contact Faculty
Sarah Williams, MD (ande8350@umn.edu)

Clinical Presentation
12 year old girl presenting with abdominal pain, and fatigue. Imaging reveals a 8.0 x 7.5 cm right lower quadrant mass. CBC is normal. Patient undergoes exploratory laparotomy with conversion to right hemicolectomy. The mass is centered around the ileocecal valve.

Images

Cytogenetics

- Dual color break apart probe for MYC locus at 8q24
- 92% had a signal pattern indicative of rearrangement of the MYC locus.

Flow Cytometric Immunophenotyping

Normal T lymphocytes are blue
Abnormal B cells are red

Slides

↓ [Hyperlink to scanned digital slide](#)

Figure 1. Compilation of screenshots of web pages to demonstrate the online format. The example provided, case 7, shows the initial landing page on top with a hyperlink to the individual case with links to larger images of the provided ancillary studies as well as a hyperlink to the digital slide. The assigned faculty member with contact information is also included on the web page.

and diagnoses. Each case consists of a brief clinical vignette, microscopic slide, and an additional study or clinical test. Examples of additional studies include digital images of flow cytometric immunophenotyping dot plots, karyograms, imaging studies such as computerized tomography scans or magnetic resonance imaging, electron micrographs, fluorescence in situ hybridization studies, and immunohistochemical stains. Initially, actual glass slides were issued to students; however due to slide loss, damage, and improved technology, most of the glass slides have been digitalized using an Aperio Slide Scanner with up to 40× magnification. The cases are accessible with any web browser or via a hyperlink emailed to the students. The cases are digitally stored in the Department of Pathology Whole Slide imaging server and students can access

the images remotely or in mobile format. Screen shots of the ISP landing page, an individual case, and the digital slide are shown as Figure 1.

Each ISP group is composed of 3 or 4 randomly assigned medical students and each group is assigned an ISP case with a faculty advisor. Some faculty advisors take on multiple ISP groups and some of the faculty advisors are the case creators. The faculty advisors are from the departmental divisions of anatomic pathology, hematopathology, and neuropathology.

The ISP extends for the entire 6-week course with a timeline to help keep each group from falling behind. In the first week of the course, ISP cases and advisors are assigned to student groups. The groups are asked to organize themselves outside of class and review the materials. Usually the students decide to

divide up responsibilities with one student taking the lead on slide interpretation, another in charge of writing the paper, a third in charge of references and so on. This organization is left to each team. By the end of the second week, the groups are expected to have developed a working diagnosis or a list of differential diagnoses and to contact their assigned faculty member to determine whether they are correct in their interpretation. This has typically been done either in person or through email correspondence. If the diagnosis is confirmed, the students may proceed to research their diagnosis and begin to compose their paper. If the diagnosis is incorrect, the faculty advisor typically arranges to meet with one or more students in the group to guide the group to the correct diagnosis. Weeks 3 and 4 are used for additional research on their topic and composition of the paper. Online web-based shared documents are often used which can be edited by members of the group at the same time. The groups are encouraged to use their assigned faculty member as an open resource if they have additional questions. By week 5, the students should be finalizing the 3- to 5-page report on their case since the paper must be submitted by email by the midpoint of week 6 of the course, before the final exam.

Since the course in which the ISP is embedded covers basic, not organ system, pathology, it is a requirement that the basic science aspects of the case be discussed within the report. Instructions of expectations are given to the students in the first week of the course. An outstanding paper from the prior year is posted on the course website to provide the students with an example of what is considered excellent. Students are expected to use primary source references in addition to using the course textbook. The number of references is limited to no more than 10.

In the final stage of the ISP, a group of faculty members from the University of Minnesota's Laboratory Medicine and Pathology Department is recruited to review the papers. Frequently, this group of "judges" has included basic scientists as well as anatomic and clinical pathologists. Faculty members are assigned 5 to 8 papers each, and examples of prior excellent papers were provided to faculty members upon request to help with assigning a grade. The faculty reviewers are also asked to choose the best paper from the collection they have reviewed. The best papers from each faculty member are reviewed by a smaller faculty group and the course director and a consensus reached of the top 3 papers of the year.

Because an important goal is learning to work together collaboratively within a group of professionals, every student is required to submit a brief peer assessment evaluation at the end of the ISP. An email to each student provides the hyperlink to the online survey. The nonanonymous 2 question survey asks students to evaluate the contribution of their own group members. Specifically, one survey question asks, "Does this student deserve to receive: fewer, the same number, or more points than the rest of the group?" A second survey question asks the student to rate each group members' level of contribution to the success of the project with choices being "unacceptable, low, medium (adequate), or high." It is felt that by adding a second

similar question, it would eliminate, or at least identify cases of potential "mis-clicks." Each of the students in a group is able to see the comments of their group peers. Figure 2 shows examples of the survey results for questions 1 and 2. Students have the chance to provide feedback or comments pertaining to individual group members in a free-text field. Figure 3 shows 2 examples of student feedback pertaining to group members. Completion of the survey is mandatory and students are informed at the beginning of the project that failure to complete the survey will result in losing all of the project grade points. Students are given a week to complete the 2-question survey. The ISP grade represents typically 15% to 18% of the total course grade. The course director handles all challenges to grades on an individual basis.

At the initiation of this project, the University of Minnesota Medical School had an Honors/Pass/Fail grading system. Previously, under this grading scheme, if a student received 2 or more peer evaluations deeming that they deserve a higher grade than the group, then their grade increased to Honors if the group received a Pass, and if the group received Honors, the individual received 5 extra points for the project grade. In contrast, if a student received 2 or more evaluations deeming that they deserve a lower grade than the group, the student's grade will drop from Honors to a Pass, or they will have 5 points deducted from the project grade. In 2018, the University of Minnesota Medical School embraced a Pass/Fail grading system, and so the ISP changed from Honors/Pass/Fail to Pass/Fail to match the Medical School grading system. Although Honors was no longer an option, the extra points and deducted points remained as results of the positive and negative peer evaluations.

Results

Over 7 years, it is estimated that 1190 students have participated in the ISP at the University of Minnesota. During that time, only 3 have received a failing grade, and all 3 were the result of not completing the survey. Usually each year we have had a small number (2-4) of students who have had the project points increased or decreased as a result of the evaluations of their peer group members. The University of Minnesota Medical School has a standard evaluation survey which is sent to all students at the end of every required course and clerkship. These evaluations are lengthy and time-consuming for the students and contain a number of required elements. Thus, we have not been able to add a standard question on student satisfaction with the ISP project. However, in the generic overall comment section of the course evaluation document, we have received feedback regarding the ISP over the years.

Student feedback of the project has varied substantially with some commenting that it was "fun to write and it was a good exercise in teamwork." The most common theme was the expression of irritation about the grading scale and with student dissatisfaction with the outside-of-class time required by the project. A few students have commented that they could have done better writing the paper on their own.

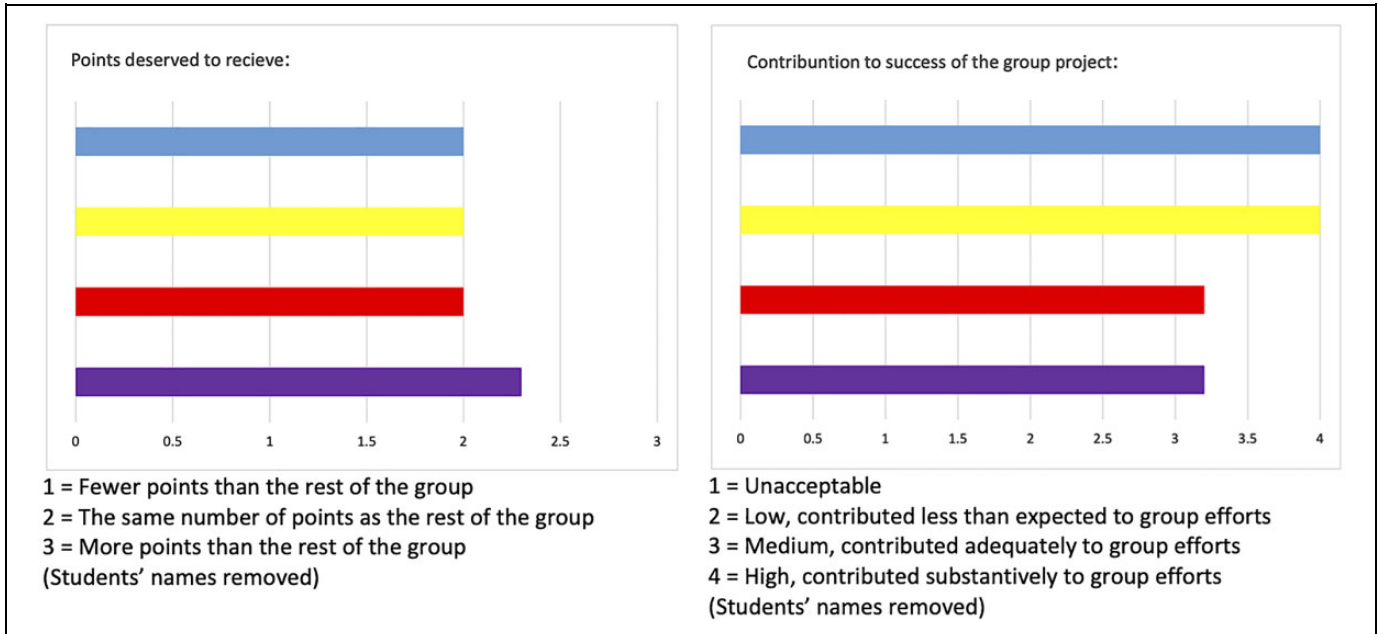


Figure 2. Results from the peer evaluations on a group member for survey questions 1 and 2. Names of the students evaluating the group member have been removed for this publication. For survey question 1, “points deserved to receive,” the assigned point value corresponds to 1 = fewer, 2 = the same, and 3 = more points than the group. Survey question 2 emphasizes a similar theme by asking the students to score the group member according to their contribution to the success of the group project. Inconsistencies between these 2 questions can provide insight if the survey questions were misunderstood or in the case of a “miss-click” and prevent a student from inappropriately receiving a poor evaluation.

Student:	[REDACTED]
Question:	Comments Required if you rated this student Unacceptable. Optional if you rated this student High, Medium, or Low
Response Rate:	100.00% (2 of 2)
1	Was highly communicative and worked well ahead of schedule to ensure there was plenty of time to edit/go over everything together. Great partner!
2	Was a great group member- she helped keep us on task, did substantial organization of your final paper with references.

Student:	[REDACTED]
Question:	Comments Required if you rated this student Unacceptable. Optional if you rated this student High, Medium, or Low
Response Rate:	100.00% (1 of 1)
1	Led the team in making sure we were on track of deadlines. Put exceptional effort into laying the groundwork so that our project could be put together smoothly. Wonderful classmate to work with.

Figure 3. Students' feedback on 2 members from a team. Names have been redacted.

The faculty members who have recently participated in the ISP were given a survey about their experiences of working as a facilitator. Twelve surveys were sent out and 11 faculty members replied. Every faculty member (100%) agreed that the time requirement for an individual faculty member to participate in the ISP was reasonable. Most (73%) also agreed that the ISP can provide a meaningful opportunity for faculty to interact with medical students in the preclinical years, while the remaining 3 faculty participants chose the response of “somewhat agree.” All of the faculty members believed that the current ISP project

format was either conducive or could be slightly modified to accommodate current COVID-19 social distancing guidelines. In fact, one faculty member commented that “As time went on (even pre-COVID), the students wanted to interact more often electronically (versus review cases face to face). It’s a good example of how the way that we interact with the students and teach them is changing—if we want to connect with them, we have to meet their needs by adapting to using technology for short, meaningful interaction.” In all, the majority of the faculty members (82%) felt that the ISP project was an enjoyable experience.

Discussion

This 7-year experience of providing real pathology cases to medical students during the basic pathology course at the end of their first year of medical school has offered unique learning and teaching opportunities for both the medical students and pathology faculty. This experience also incorporates standards for active, learner-centered and group learning issued by the Liaison Committee on Medical Education publication "Structures and Functions of a Medical School."² The ISP builds on fundamental knowledge presented in the first semester where the students are first introduced to microscopy, navigating physical slides as well as digital slides, and basic histology. The slides for the first semester histology course and those related to the ISP are now nearly entirely reformatted to digital slides. The students have adapted well to the digital modality and some even prefer the flexibility of an online platform. The surge in digital pathology technology, as a result of the COVID-19 pandemic, has allowed for the opportunity to improve our case database, easily adding and updating cases. The students' foundation of microscopy is further expanded with cases to illustrate principles of inflammation and preneoplasia in the first semester of their first year. Pathology cases and topics are also brought up and explained throughout the year so that the pertinent basic science points are covered prior to the ISP.

The students are introduced early in their medical school education in the use of collaborative online platforms such as Google Docs, Google Sheets, Google Slides, and so on. By the time this project is assigned, all students are well versed in utilizing online, collaborative documents. The individual student's role is to effectively collaborate as a member of a team which uses problem-solving and critical thinking to render a diagnosis, and then to compose a paper. In the first 2 years of this project, an oral presentation, rather than a research paper, was the requirement. We had originally hoped that all of the students would come to hear the presentations along with our faculty. However, after trying this for 2 years, we realized that trying to schedule over 40 presentations in a 2-day period imposed an impossible burden in scheduling faculty, and student attendance fell off except for the presenting group, so we decided upon a research paper.

As stated above, at the end of the second week, the students must present their working diagnosis or differential diagnoses to their faculty advisor. During these occasions in week 2, there is a unique chance for practicing pathologists to meet one-on-one with students in the student labs, in a faculty office, or in the sign-out room around multiheaded microscopes. This opportunity to convene with medical students early on in their education offers young learners an introduction to the field of diagnostic pathology and exposes them to how a pathologist approaches and works up a patient case. The opportunity to interact with a practicing pathologist highlights the importance of pathology in clinical medicine. This opportunity to reach out to medical students in the preclinical years provides students with both professional feedback and positive and meaningful

insight in the field of pathology. Some students have even asked to shadow specific pathologists as a result of the ISP and others have been stimulated to take pathology electives in their third and fourth years.

The ISP project is part of the Principles of Pathology course which is given in the last 6-week semester of the first year of medical school at the University of Minnesota, Twin Cities campus. During this course, topics in basic pathology including cell injury and death, inflammation, coagulation and thrombosis, and neoplasia are taught as well as additional lectures on introduction to laboratory medicine, molecular pathology, and transfusion medicine. In addition to lectures, small group, case-based, 2-hour laboratory sessions are held weekly. This course follows the second semester physiology, microbiology, immunology, and neuroscience course which together provide an important foundation for the organ-specific pathophysiology and pathology courses in the second-year curriculum. Despite the fact that the students are early in their medical education, we have found that they are quite good at using clinical information and this introduction to basic pathology to begin to recognize the diseases represented in the ISP cases. Because the main purpose of the Principles of Pathology course is to emphasize the basic science underlying human disease, the single essential requirement of the ISP report is to discuss some aspect of the basic science represented in each case.

Other than this requirement that an aspect of basic science be covered, there is no set format or criteria for the remainder of the report. The intentional lack of a preset format for the paper encourages self-directed learning, allowing the pursuit of areas of interests within their assigned case. The students are encouraged to explore and write about what has interested them in their case and therefore be more "learner centered." For example, in the case of Burkitt lymphoma, the students may decide to discuss how dysregulation of the c-Myc gene leads to tumorigenesis. This basic science objective ensures that the first competency, "disease mechanisms and processes" as established by the Pathology Competencies for Medical Education (PCME) is included and is emphasized.³ Despite not having direct, formulaic instruction on what to include in the paper, student groups almost always demonstrated knowledge in the other 2 PCME competencies, "organ pathology" and "diagnostic pathology."^{3,4} Based upon the case vignette and additional tests, the students were always able to highlight a meaningful basic science component. The learner-centered approach allowed individuals to explore their own interests. For example, the group members could choose to focus on treatment strategies, classic imaging findings, typical ancillary testing work up, molecular diagnostics, gene therapy, and anything else that they were individually interested in learning about. This creativity proved to be important for student engagement in the project and also for papers that were enjoyable to read for faculty. Each member of the groups submitting the top 3 papers received a prize, which in the past have been \$35 Amazon gift cards. However, recently we have been rethinking this part of the project as the prizes have been met with some criticism from students as patronizing or elitist.

The peer evaluations can lend insight to a student's actions and behaviors during the team project, thereby providing a snapshot of a student's professionalism. Email reminders from the Medical Education Office are sent out with increasing frequency as the deadline approaches. Only 3 students in 7 years have failed to complete the peer evaluation survey. In the great majority of cases, students have credited one another with leadership qualities and admirable teamwork. This peer evaluation has the potential to positively redirect an early medical student in their professional collaborative behavior. The peer evaluation can also foster medical students' identities as future leaders. Student feedback collected in the course evaluations, although anecdotal, also provides valuable insight for future improvements for the ISP going forward.

This ISP project has been well received by both students and faculty members while providing a unique team-based learning activity for undergraduate pathology education which can be easily implemented during the current COVID-19 pandemic. We believe that projects such as this also provide an important opportunity to introduce medical students to the actual practice and work of pathologists early in their medical school careers.

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