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The Math Games Seminar: A Mathematical Learning Community

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Abstract

Learning communities can be an effective means of engaging university students across disciplines. Games have always been a source of both enjoyment and interesting mathematics. Based on our own interest in games, and the deep, strategic discussions we found ourselves having with students when we played games with them, we decided to design a learning community around the mathematics of games. We hoped in particular that such a community could be a great pathway to introducing mathematical thinking to students not majoring in mathematics, and that they would gain a greater appreciation for our field. In this paper, we describe our Math Games Seminar learning community, from its origins in 2016, to its organization and to its impact on our students through the years.

Keywords: learning community, games

1. Introduction

Games can be a fun social activity and a great way to enjoy the company of friends. However, playing games and analyzing optimal strategies to win a game utilizes many of the same skills as solving problems in mathematics.

With this in mind, we decided to create a course at our university to engage students in the process of playing and analyzing optimal strategies of games.

Initially, we began by playing games with math majors in our office suite to pass time between classes. We started out playing games by the published rules, but quickly learned it was more fun to see what would happen if the rules were changed, so everyone had to figure out a different strategy. For example, most of our students had a strategy for optimal play in Jenga, but what happens if the block pattern spins at each level; how does that affect the stability of the structure? Students seemed to really enjoy defeating their professors in epic battles, and we really enjoyed getting to know our students outside of the classroom.

Around the same time, our university decided to implement a new general education curriculum which included a learning community requirement for all students. Reflecting on how much enjoyment the students seemed to get out of playing games and how accessible the ensuing discussions were, even to non-math majors, we decided to create a learning community-based course where we played and discussed games with students.

This course, the "Math Games Seminar," was first run in the fall of 2017 and has run every semester since, continuing to remain popular among students of all disciplines. Although many students initially take the course as a means to fulfill a graduation requirement, the vast majority of students report to us in their end-of-semester reflections how much they ended up enjoying the course. Further, they are able to appreciate how mathematics can inform game strategies, be it a classic or a modern game, and how a game can be designed to ensure new players are not at a significant disadvantage.

In Section 2, we explain why we chose games to engage our students in mathematical thinking as well as describing our university's learning community requirement and how enrollment of the course has evolved since it was first offered. We discuss our organization of the course and the choices of games we play in Section 3, and then we conclude with our reflections and our students' reflections in Section 4.

2. A Mathematics of Games Learning Community

In the early 1990s, colleges and universities were looking into ways to improve the educational experience both inside and outside of the classroom. Two works published at that time led to the development of learning communities as a way to meet shortcomings in the college experience. The first, by Vincent Tinto at Syracuse University, *Leaving College: Rethinking the Cause and Cure of Student Attrition* [13], found that building an inclusive community within the campus is just as essential to retention as what happens within the classroom. Alexander Astin published *What Matters in College: Four Critical Years Revisited* ([3], also see [4]), where his team found that the student peer group was one of the most important factors in student retention. A close second would be the frequency of interaction between students and faculty. Learning communities were developed as a way to achieve these goals and provide integration between what happens in the classroom with what happens outside of the classroom.

More specifically, a *learning community* is defined as an intentionally developed community that will promote and maximize learning. In their original construct, these often consisted of a combination of academic classes that were supplemented by extracurricular activities. The academic classes had some common theme to help students see an integration of ideas across disciplines. In this model, a cohort of students would be enrolled together in these classes, and the hope was that this would help to enhance student engagement and enrich their educational experience while helping students develop a greater connection to the university. Similar learning communities had existed before for special cohorts of students (such as honors programs), but now the goal became to expand their use to the general student population.

Since this movement began, learning communities have emerged in colleges and universities across the United States. The benefits of these interdisciplinary community building activities have been well documented. For example, [7, 9] demonstrate positive outcomes for students in underrepresented minority groups. This is of particular interest for those of us in mathematics where these student groups are even more underrepresented. In math in particular, the most recent NSF survey from 2014 found that women earned 40% of bachelor's degrees, but fewer than 30% of doctoral degrees.

The disparity is more jarring when we look at race and ethnicity: for bachelor's degrees, fewer than 5% are given to black students, while fewer than 8% were given to Hispanic students [8]. At our university, we have several initiatives related to the retention of these minority groups, so the positive impacts of learning communities stood out as something to investigate further.

In addition, learning communities have shown positive outcomes with respect to retention and creating community within the campus (see for example, [6, 12]). While many studies were done on more traditional learning communities where students are either in a cohort of classes or housed together, there has been a desire to achieve similar outcomes for all student populations. Unfortunately, the standard model does not always work for all student populations. For universities that have a large number of transfer students who are further along in their academic studies, or have a large number of commuter students who are only on campus a few days a week for their courses, it can be difficult to engage these students in one of these more traditional learning communities.

We teach at Benedictine University, a small liberal arts university which is located in a suburb outside of Chicago, IL. Here, a large percentage of our population consists of students that fall into those harder-to-serve groups. In the fall of 2018, our student population consisted of 77% commuter students, and 39% of our students transferred from other institutions. While our university created several courses in the traditional cohort learning community model aimed at first years, the university had a goal of enrolling all students in a learning community. To do that, a new type of learning community needed to be created.

As a solution, our university proposed a hybrid model of the learning community to reach these more difficult populations. This learning community would be in the form of a stand-alone course with a goal of building community among those students enrolled. The hope is that such courses could still provide the same benefit in terms of engagement with the university as the more traditional cohort model.

Our Math Games Seminar course was intended to fit into this paradigm. It's a zero-credit extracurricular course experience designed to be an extension of the classroom; we're focused more on facilitating student-faculty interactions,

rather than transferring academic content. It also gives students an opportunity to engage with faculty and other students outside of the classroom. In our learning community, students would come together each week to play games.

The Math Games Seminar is intended for a general student population. While designing it, we hoped that students who took our course would leave with a more positive attitude about mathematics after engaging in the mathematical process as we discussed strategies during game play.

More and more instructors are using games in the classroom as a way to create a more active learning environment. The skills used in game play strategy are very similar to those needed to be successful in mathematics. Several recent studies have discussed how including games in the mathematics classroom can improve student learning outcomes. In [10], the author focuses on games that include specific math concepts, like *Bizz Buzz*, which helps students learn multiplication facts, or *Test Review Jeopardy*, as interactive additions to the classroom to help students practice course material while having an engaging and entertaining experience. Still others have created computer games, like E-Brock Bed Bugs [5] among others, which engage students in mathematics while they play the games.

Our use of games is less overt: as we want to introduce the mathematical process during our strategy and game modification discussions, we do not focus on any specific mathematics concepts. Often, our discussions are probabilistic in nature, but we are not teaching probability specifically in class. Students are instead seeing the problem posing process that is essential in the discovery of new mathematics, a process we highlight in our discussions. We aim to show our students one does not need to be an expert mathematician to engage in mathematics creatively. Meghan Riling defines the concept of mathematics creativity in [11] as actions that transition a given mathematical context (for us, the way game play is defined in the printed rules for the game) to a new version of mathematics (for us, a modification to the rules or an investigation of a strategy where the players add additional constraints to their own game play to determine optimal moves). Riling then argues that it is to the benefit of the mathematics profession to think more broadly about what it means to do mathematics. We firmly believe that the students enrolled in our learning community are doing mathematics.

Especially for our non-major participants, we hope to show them that mathematics can be a very pleasurable activity. As we discuss the games played in the following section, we will illustrate how this mathematical creativity was encouraged for a few specific games.

In this paper, we reflect on three years of running this course, from its creation in 2016 and first run in the fall of 2017 through the most recent pre-pandemic iteration in the fall of 2019.

The first semester we ran our course was in the fall of 2017 and we had only two students, both math majors. These students had interacted with us as faculty for their major classes several times, so while our class was not connected to a specific math class, the experience was much more similar to a traditional cohort model learning community, as we already knew the students well. After that, the course became more popular as the original students shared their experience. In the spring of 2018, we had 10 students from more diverse majors. Table 1 displays our student enrollment numbers by term and the majors. As the course gained popularity, the enrollment fluctuated, which definitely changed the overall student experience.

Table 1: Student enrollment numbers per installment.

Term	**Science & Math**	**Business**	**Education & Health Services**	**Liberal Arts**	**Percentage Senior**
Fall 2017	2	0	0	0	50%
Spring 2018	7	2	0	1	50%
Fall 2018	4	5	0	0	56%
Spring 2019	4	4	0	0	88%
Fall 2019	9	0	0	1	100%
Spring 2020	5	0	2	2	89%

For reference, students in the College of Science had majors in Biology, Biochemistry and Molecular Biology, Computer Science, Computer Information Systems, Health Sciences, Mathematics, and Physics. The students in the College of Business had majors in Business Analytics, Business & Economics, Finance, Marketing, and Management & Organizational Behavior. The students in the College of Education and Health Services had majors in Exercise and Sports Studies. The students in the College of Liberal Arts had majors in Communication Arts, Psychology, Sociology, and Writing & Publishing.

As our enrollment increased, many of the enrolled students had not had either of us as an instructor in a math class. Also, many students had heard that our learning community was fun but did not necessarily care much about playing games. They enrolled in our course as a way to "check a box" on their general education requirements. While we found that we could still have an enjoyable course experience with these students, it definitely required us to be more creative in our strategies to engage all students in the class. In Section 3.3, we will discuss some of the strategies we employed in more detail. Additionally, in recent offerings, this course has been taken largely by seniors at the university who are trying to fulfill a final general education requirement. We are not sure how effective we have been at facilitating further student-faculty interaction with this population, as these students are already getting lots of faculty interaction in their major classes.

3. Nuts and Bolts of Our Course

Since the Math Games Seminar is designed to be a learning community, and since it counts for zero credit hours, we definitely did not want to run it like a typical mathematical lecture course. In fact, we teach the course mostly through play and discussion, with very little actual instruction outside of some basic terminology (presented on the first day of class) and then the rules for the games as appropriate.

3.1. Choosing the Games

At the beginning of the course, students are introduced to two key definitions for analyzing games:

Perfect Information Game: This is a game where all information is available to all players at all times. This allows for current moves to be known as well as future moves to be predicted, which means the game is potentially "solvable". Games that fit this description include Chess, Checkers, and Connect Four.

Optimal Player: This refers to a player who makes the strategically best move at all times and never makes a mistake that could be capitalized on by their opponent. This also assumes that the player is actively trying to win the game.

With these definitions mentioned, we begin the semester by playing and discussing two perfect information games: Connect Four and Super-Tac-Toe. Super-Tac-Toe is a variant on the classic Tic-Tac-Toe game,[1] but is much more involved. The rules are as follows:

The two players play to get three of their mark (X or O) in a row on a 3-by-3 grid of boxes, just as in the standard Tic-Tac-Toe. However, in each of the boxes is another 3-by-3 grid. To claim a box on the larger grid, a player has to get 3-in-a-row on the smaller grid contained in that box.

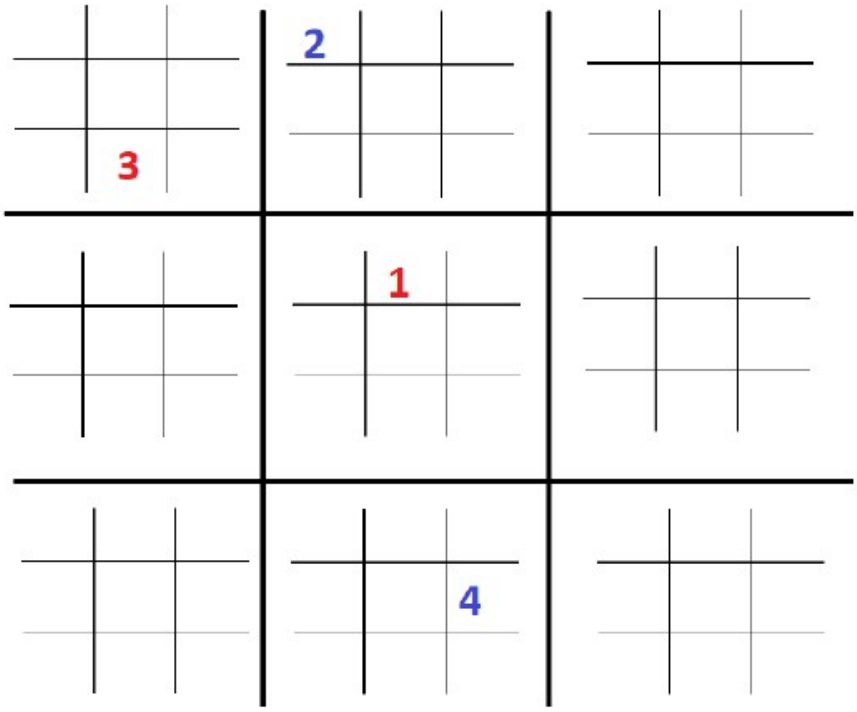

Figure 1: An example of a Super-Tac-Toe game in progress

In more detail, the game starts with the first player picking any of the available grids and placing an X there. For example, in the included sample game, the first player could place their X in the (1,2) position in the (2,2) grid

[1] See https://en.wikipedia.org/wiki/Tic-tac-toe if you are not familiar with the game Tic-Tac-Toe.

(labeled with the red number 1). The second player then has to place their mark based on where the X player placed their mark. So, in the example game, the second player must place their O mark anywhere in the (1,2) grid. In the example game, O put their mark in the (1,1) position in this grid (labeled with the blue number 2). The next X must then be placed using the same rules, but based on the position the last O was placed. Therefore, X must play somewhere in the (1,1) grid, for example, placing an X at the (3,2) position (labeled with the red number 3). This continues until a grid has a decided outcome (X wins, O wins, or a tie game).

Now, going forward, if a player would be forced to play their next move in a grid with an already-decided outcome, then they can place their mark *anywhere* on the board. This continues until the larger grid has a 3-in-a-row winner, or it becomes impossible for either player to win, in which case the game is declared a tie. Students tend to really like this game as it gives a deep layer of strategy to an otherwise simple game, and lots of discussion ensues between players as they try to think two or even three moves ahead.

The second perfect information game we play is Connect 4, which we play because it is easy to explain, many students have already seen it, and it can be played really fast.[2] After the students have played it a few times and track which player (first or second) wins the most frequently, we talk about how this game could be analyzed. For example, what would happen if both players tried not to win; could the game end in a draw? What is the optimal strategy to win this game? Does the order of play matter? Students spend the entire class investigating these questions through play, and we end with a discussion of their conjectures. Then, we show them the paper "Expert Play in Connect-Four" [1] by James D. Allen, which led to the book *The Complete Book of Connect 4* [2], where the author analyzes the ideal strategy for winning Connect 4. We then compare what the paper says is the expected outcome with two optimal players (Player 1 should win) with the results the students obtained through their games. We end by showing the students that they may not have realized it, but they were participating in real mathematics!

[2] See https://en.wikipedia.org/wiki/Connect_Four for a brief overview if you are not familiar with the game Connect Four.

We continue to employ this strategy of modifying games as the semester continues. This helps students understand how the rules of a game can really impact the strategy. For example, one game we often play later in the semester is SET, where students work independently against each other to try to determine a set of three cards that are either all the same or all different in each category.[3] A modification to this game is to require, instead of finding a single set, finding two overlapping sets that share a common card. How does the strategy change? Why is this more difficult? We can modify even further to make magic squares of sets and then analyze the permutations of these squares that will still work. Can we classify our magic squares into types? In these subtle ways, we are introducing mathematical thinking without overtly explaining our intent.

In the third week, we play the more modern game Tsuro, published by Calliope Games.[4] This is the students' first exposure to a game that is played in a large group (it can accommodate up to 8 players; when we had more than 8 students we had them participate in pairs), but it is also their first exposure to a non-perfect information game, as players have hands of concealed tiles that are only revealed on their turn. The game also fits well with the course, as it plays quickly (only about 15 minutes per game), it doesn't require any more time to play with 8 players vs. 2 players, and it is a game that has some clear strategy to it, but no player will win every single time.

After this, the rest of the semester consists of playing games that are largely not perfect information and tend to be more modern, but still have some discernible strategies. We also vary the games so that, some weeks, we split the class in half so each half plays a different game, switching to the other game the following week, and other weeks feature large group games that we all play together.

At this point, we introduce another concept: concealed vs. open scoring. An *open scored* game is one where the point scores of each player are known, or can be figured out, at all times during the game, such as Scrabble.

[3] See https://en.wikipedia.org/wiki/Set_(card_game) if you are not familiar with the game SET.

[4] See https://en.wikipedia.org/wiki/Tsuro if you are not familiar with the game Tsuro.

On the other hand, a *concealed scored* game is a game where some of the points scored are hidden from other players and only revealed at the end of the game. This feature is significant in one of the games that we play: Sheriff of Nottingham.

In a typical semester, we feature the following games (if a modern game, we include the publisher and original release date):

- Our "starting three" (Super-Tac-Toe, Connect Four, Tsuro);
- Qwirkle (MindWare, 2006);
- Mille Bornes;[5]
- 7 Wonders (Asmodee, 2010);
- Slide 5, aka 6 Nimmt! (Amigo Spiele, 1994);
- Sheriff of Nottingham (Arcane Wonders, 2014);
- Set (SET Enterprises, 1988);
- Blokus (Educational Insights, 2000);
- Codenames (Czech Games Edition, 2015);
- Exploding Kittens (Ad Magic, 2015).

In choosing the games to be played during the semester outside of the first three games, we try to pick games that fit a number of qualifications:

- The students are unlikely to have played the game before, so they will all start on a roughly equal playing field.
- The game can be played at least twice in a 75-minute period while also allowing time to explain the rules and to discuss strategies at the end.

[5] See https://en.wikipedia.org/wiki/Mille_Bornes if you are unfamiliar with the game Mille Bornes.

- The game has discernible strategies that players can use to give themselves an advantage, but they may not be obvious to a first-time player.
- The game will typically not be played quietly; that is, talking and socializing are necessary for the game.

While the games in the included list are played consistently from semester to semester, we have swapped out games from time to time due to either lack of student interest and/or students not really perceiving any strategies to the game. One example of such a game was Secrets (Repos Production, 2017), a card game where teams work together to score the most points ... but no one knows initially who else is on their team. While this game showed initial promise for our course because of players needing to interact with each other in order to figure out who was on what team without giving any information away to the other team, students found the game too confusing or, in some cases, too easy to solve who was on what team. Thus, we decided to retire the game and look for one that had similar game mechanics, but wasn't as confusing.

3.2. Rules for the Course

Since our Math Games Seminar course is not worth any credit hours, it is only graded on a Pass/Fail basis (this is a policy at our university). Further, because it is a learning community, almost everything takes place in the class time, save for one final assignment.

In order to earn a Pass, we insist that students do the following:

- Attend each class session and fully participate in playing and discussing each game.
- If the student must be absent, they must provide appropriate documentation, and can only be absent a maximum of two (2) times during the semester. No unexcused absences are allowed.
- Students cannot be more than 5 minutes late (since it takes time to start a game and explain the rules) without a proper excuse, or it's an unexcused absence.

- Students cannot be on their phones during the class session unless a game requires it, as they need to be fully participating in the games.
- Students must complete a final reflection essay (required of any learning community experience at our university), submitted during the final exam week.

For the final reflection essay, we ask students to discuss their most memorable experiences during the course, along with their favorite and least favorite games. We also ask them to discuss how they felt the course experience was as a whole; namely, did it fit the definition of learning community, and did they believe it to be a positive experience?

While the feedback from these essays has been very useful to us as instructors when planning the games and other features of the course for future semesters, we have found that students may temper their comments since the essays have their names on them. Thus, on the last day of class, we have also been giving them an anonymous survey that asks similar questions, but in mostly multiple-choice form. We share the results from these surveys (and essays) in Section 4 of this paper.

3.3. Who Plays With Whom?

When we developed this course, our goal was to focus on positive interactions between students and faculty as these are seen as crucial to student persistence, which was ultimately the goal of these learning communities. Therefore, we began by looking into ways of developing groups that would be more conducive to creating a strong community. We want students to enjoy themselves, of course, but we also want them to get to know people that may be of different majors or backgrounds than they are. Also, as we get to know different students' attitudes toward different games and the course in general, we take that into account when making the groups.

Of course, for large group games, we don't worry too much about who plays with whom, since everyone is playing the game together. But, especially for the games where we split up the class, which students play together can be vital to whether it will be a fruitful experience or not. Thus, for the first few weeks, students are allowed to self-select their playing partners.

We do this to see how seriously each student is taking the course experience (some students will openly discuss the games and be competitive with each other, while some may play minimally and not say much) and to see who comes into the class with already-existing friendships. After that, we start mixing up the student groups somewhat randomly while paying attention to the following dynamics:

- We want people to try and leave their comfort zones, so, at least once, we will force the already-existing friendships in the class to play apart from each other.
- We want to ensure that every student plays with every other student in the course in a smaller-group experience at least once.
- If a student is exhibiting a poor attitude toward the course experience, we will usually make sure that they are playing with someone that is greatly enjoying the experience and is very outgoing in hopes of influencing the one with the poor attitude.
- Likewise, if a student tends to dominate discussion concerning strategy, we make sure they are playing with another player that is very outgoing so that one person doesn't control the entire discussion.
- In the worst case scenario, if we have a student whose attendance is spotty, we put them in a group where they can simply come in the middle or join a team and be minimally disruptive (we usually put this person in a larger group as a result).

We have found that it typically takes about 3-4 weeks before we have the students and their personalities pegged and when we can design productive small groups. One of the more important dynamics we've noted is that, even if a student with a poor attitude isn't really influenced by people with good attitudes, the other players with them are more likely to enjoy themselves, so it can still be beneficial for the group as a whole. Thankfully, students with poor attitudes in the course are not common, as there are plenty of other learning community experiences at our university, but we have had a few.

These students tend to be seniors who were forced to take a learning community at the last minute, not realizing it was a requirement for graduation, and so they view the experience as "checking a box".

4. Student Reactions and Challenges

Because the Math Games Seminar experience is very different from the typical course experiences we have offered in the math program, and the students we have interacted with are usually quite different from our typical science majors present in our courses, we were interested in seeing what our students had to say about the experience as a whole. Namely, did they enjoy it, and did they feel like they learned something in it? And, of course, did they feel that what we were offering was satisfying the goals of a learning community?

At the end of each semester in which the course was taught, the students were asked to complete an anonymous survey that first asked their opinions on the different games played throughout the semester, followed by questions concerning the learning community experience itself. At the end, the students were invited to offer additional open-ended comments about the experience.

For the questions concerning the learning community experience, students were presented with a statement and asked to rate their opinion on that statement from 1 (=Strongly Disagree) to 5 (=Strongly Agree). For the 35 students who took this course between the Fall 2017 and Fall 2019 semesters, their responses to our key questions are given in Table 2.

Table 2: Student responses to survey questions.

Question	**Agree (4 or 5)**	**Neutral (3)**	**Disagree (1 or 2)**
I feel like I got to know everyone in the group, including my professor.	34	1	0
There was a good amount of strategy discussion as well as playing games.	32	3	0
The professor designed an inclusive environment where everyone was treated as equals, and everyone's opinions were respected.	35	0	0
Overall, I feel this is a good example of a learning community.	34	1	0

In addition to the data collected from the surveys, we also have received some substantial feedback from the end-of-semester reflections that students wrote, much of it being positive. Of course, we do take these comments with a grain of salt, as these assignments are not anonymous, but this does not mean the comments are not valuable, as they offer an insight to what, specifically, students enjoy about the experience. For example, many of the students, regardless of major, tell us that they come into the experience not really knowing what to expect and that they see it as a burden, but they end up really liking the course because they get to interact with different people than they otherwise would. As an example, one student from Fall 2018 shared that, "I hated the idea of coming to class just to play games but found myself wanting to play more and wished class time had not ended."

A number of students have also shared that they relish the chance to take a "break" from their rigorous course work and have a good time with friends, old and new. One student in particular mentioned that, "... words can simply not express how much [this course] meant to a student ... who needed a way to have a source of stress relief to look forward to throughout the weeks of the semester." This quote came from a student in the Spring 2018 semester, but we have seen comments similar to this from numerous students in each semester since. Still another takeaway noted by a Fall 2019 student was, "I could tell that no-one was distracted by any external stimuli or other-worldly thoughts, and were only focused on determining the pattern that was (quite literally) right in front of us", showing us that this student (and others who made similar comments) are fully engaged in the environment.

While math and science majors tend to come into the experience having a bit more knowledge of what it entails and likely already enjoying the idea of playing and analyzing games, we wanted to make sure that our non-science majors are getting something out of the experience as well. We assumed that math and science students would enjoy studying game strategy, but would non-science students? The good news is that, based on the feedback we received, yes; these students became just as enthusiastic about the games in most cases as the math and science students! Many stated specific skills they could take beyond games into other courses or their careers. For example, a student from Spring 2019, who happened to be a finance major, stated one of his takeaways was that, sometimes, his best-laid plans went awry when playing, much like in the business world.

Of course, while we have largely enjoyed the experience of teaching the course greatly, and our students have largely been appreciative and enthusiastic about the overall experience, we have also encountered some occasional challenges. One of our biggest challenges has been that the course is taught in addition to our standard teaching load. Since the course is zero credit hours, the instructor does not receive any compensation for teaching it. Thus part of the reason we have team-taught the course is to relieve some of the burden of teaching an additional course on top of an already-heavy teaching load—our university requires a 12-credit hour standard teaching load each semester. We also are skeptical, because of this, that anyone else would be interested in teaching the course.

This also highlights another difficulty: There is only one instructor of record, so the other instructor is not officially scheduled for the course. This means that that instructor could be scheduled for committee meetings or other service obligations, forcing a last-minute redesign of the games that we play. In fact, one semester, one of the instructors was out on maternity leave, and so, to be able to do the split-group games, we had to ask for math major student volunteers. While these student volunteers were generous with their time at first, once the semester's demands kicked in, they were no longer able to assist, forcing the instructor to play the remainder of the games in large groups.

Finally, because we are required to meet in our university's pre-scheduled time blocks, one semester, due to other obligations, we were required to hold the course in a 50-minute time block instead of a 75-minute one. This ended up being a disaster, due to typically only getting to play each game once, forcing some games to be set aside due to their complexity, and students coming to class late really messed up getting everyone on board quickly enough to start playing. We have been able to avoid this issue since then.

One difficulty we did not anticipate is the impact of COVID-19 on this course, as this experience is centered on in-person, face-to-face interaction. Because we had to offer asynchronous options for students to complete course work during the pandemic, we decided it was easier to simply end the course early in the Spring 2020 semester, which was disappointing both to us and to the students in the course. With improved technology capabilities and numerous free online game sites such as Board Game Arena, however, we are looking into ways to offer a virtual version of the experience in the future.

Looking forward, besides the continuing impact of COVID-19, our university recently switched their requirements so that students can choose to complete an Engaged Learning experience (including research projects) for graduation instead of all students needing to participate in a Learning Community. Thus, although we will continue to offer the course in the short-term, we may not be able to get enough students to offer it in the long-term. We are looking into ways to keep the experience going, such as through a student club or making ourselves available once a week for open games in our department's main office suite.

Regardless of how our Math Games Seminar evolves in the future, we have been extremely happy with the students' experiences and their perceptions of what they have learned so far, as the included data has indicated. Seeing that all students involved were able to appreciate how mathematics can inform game strategies, be it for a classic or modern game, while having fun with old and new friends suggests to us that the Math Games Seminar is indeed a wonderful example of a mathematical learning community.

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