Physical and online games for phonetics and phonology

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1. Introduction

Research has shown that students perform better in courses when they take part in active learning, which involves activities or discussions in class that engage them in the process of learning, rather than traditional lectures that require them to passively listen (Hake 1998, Freeman et al. 2014, Michael 2006). For example, Freeman and colleagues' (2014) meta-analysis of 225 studies on student performance in science, technology, engineering, and mathematics courses found that students had 6% higher scores in courses with active learning compared to traditional lecturing, while those in traditional lecture classes were 1.5 times more likely to fail. Despite these findings, many instructors may still be reluctant to introduce active learning into their courses.

One reason for this reluctance is that it can be time consuming to learn about and create new activities (Henderson and Dancy 2007). Additionally, although students learn better when they are challenged with active learning, students often feel as if they did not learn as much, because active learning is more difficult for them than passive listening (Deslauriers et al. 2019). Games have long been known to be useful ways to reap the benefits of active learning while mitigating students' perception of active learning as unpleasant, as well as increasing their engagement, participation, and ultimately, performance (Cruickshank and Telfer 1980, Lepper and Cordova 1992, Sugar and Takacs 1999, Massey et al. 2005, Ritzo and Robinson 2006). Furthermore, games can be easy to implement in the classroom, sometimes requiring little more than pencil and paper or minimal adaptation of existing games. In this chapter, we provide a framework with examples of how to create and implement games for phonetics and phonology courses.

Many games rely on matching images or numbers that can be replaced with vocabulary or symbols while maintaining the same underlying gameplay. Phonetics and phonology are particularly well-suited for adaptation to games, especially matching games, because they involve multidimensional structures allowing for many different ways of dividing up important concepts into meaningful groups of matching elements. For example, both phonetics and

phonology rely on the International Phonetic Alphabet (IPA) or other similar transcription systems, while phonology also has phonological features. These systems and features are in turn built on complex intersecting categories, such as place and manner of articulation, phonation, vowel height and backness, and feature geometry. These categories allow for many different ways for relevant game units to be matched into groups, so that a single unit may match many different other units in different ways. For example, the phone [p] could match [m] for place, [d] for manner, [x] for phonation, or [z] for [–sonorant]. Furthermore, as in other fields of linguistics, there is a lot of specialized phonetic and phonological vocabulary that works well for general memory games and word games. This is especially true for phonetics, which involves technical terminology from anatomy (*velum*, *pharynx*, *glottis*, etc.) and acoustics (*frequency*, *resonance*, *white noise*, etc.).

A notable example of a phonetics game is Lynn Santlemann's (2000) IPA Bingo, which is played by having students match IPA symbols to phonetic descriptions called out by the instructor. IPA Bingo has become a staple tool in many linguistics courses for helping students learn IPA symbols needed for English. Matching card games like Go Fish and Happy Families, where players ask for cards from other players to create matching sets, can be adapted for phonetics so that students ask each other for cards containing phonetic symbols based on their phonetic descriptions. Similarly, guessing games like Guess Who? can be adapted so that students must specify phonological features to guess their partners' hidden phonetic symbol. There are many possibilities, and by presenting our experiences in creating and using games, we hope to encourage other instructors to introduce games into their own courses.

In this chapter, we present three case studies for the design and implementation of different kinds of games we have developed to help students learn important notation and concepts in phonetics and phonology. In Section 2, Daidone discusses IPA Battleship, a paper and pencil game that focuses on an introductory subset of IPA symbols. In Section 3, Sanders discusses IPA Discard, a print-and-play card game that focuses on more advanced IPA symbols for consonants. In Section 4, Sanders discusses a family of online matching games that focus on IPA symbols, phonological features, and natural classes. We conclude in Section 5 with a summary of some of the design principles we followed that we believe contribute to effective educational games.

2. Case study #1: IPA Battleship by Danielle Daidone

In my Introduction to Hispanic Linguistics and Spanish Phonetics courses, I want students to master phonetic symbols and phonetic descriptions that are relevant to Spanish. This learning outcome involves various skills, both receptive and productive, such as the ability to write phonetic symbols, the ability to associate written symbols with sounds, the ability to describe the voicing, place of articulation, and manner of articulation represented by a symbol, and so on. Because recognition is easier than production (Krashen 1982, Cabeza et al. 1997), games that involve recognizing symbols could be a better fit earlier in the curriculum, when students have first been exposed to phonetic symbols, compared to games that require students to provide descriptions themselves, which could be used as review after additional practice. Since I wanted an interactive game played in class in which students practiced Spanish IPA phonetic symbols both by producing descriptions and by recognizing symbols, I decided this game would fit best as a review activity a bit later, after students have already learned and practiced matching phonetic symbols and their descriptions.

These stipulations also helped me narrow down the possible games to adapt. First, it could not be a game like Bingo in which students only needed to recognize symbols, and it could not be a game that was possible for students to complete alone, like Concentration (see Sanders's matching games in Section 4 for examples). Instead, it had to have an information gap so that students needed knowledge from their partners in order to progress. I decided that Battleship would be a good candidate because the players take turns asking and receiving information. Moreover, the necessity of providing a description based on a symbol and being able to find the symbol that matches a description directly mirrors the assessment that I use to test their knowledge (in line with transfer-appropriate processing theory, in which recall tasks are more successful when they match the learning tasks; Lockhart and Craik 1990). On their exam over this material, they need to provide the descriptions for different phonetic symbols, as well as provide the symbols for different descriptions. Thus, Battleship would be a relevant review activity.

I also chose Battleship because I would not need to make special card decks or a complicated gameboard. For IPA Battleship, instead of having a gameboard where squares are identified by letters and numbers, each square contains a phonetic symbol. I manipulated the number of squares so that they matched the number of phonetic symbols we had studied in class.

In my version, I had 32 symbols, so I created a 4 x 8 gameboard, but this could easily be adjusted depending on the number of phonetic symbols you prefer. Keep in mind that the higher the number of squares you use, the more places there are for students to place their 'ships', and therefore the longer gameplay will likely take (and consequently, fewer symbols will result in a shorter game). I suggest having gameplay of at least ten minutes or making students play multiple rounds. If the game takes more time to explain than to play, it is not well suited for the classroom.

Since students might see playing a game as frivolous, it is important to explain to them that active learning is more useful than passive lecturing because they are more cognitively challenged. This information improves their perception of active learning, increasing buy-in (see Deslauriers et al. 2019 for more detail). Thus, when I introduce students to the concept of the game, I explain how it will help them memorize the descriptions for phonetic symbols. I then project the gameboard on the screen and tell them to copy it exactly as shown (Figure 1). While I could have provided students with the gameboard, I decided it would be more useful for them to create it themselves. This adds time to the preparation phase of the game, but it saves me time in class preparation, and more importantly, it forces students to practice writing phonetic symbols. Based on previous experience, I now preemptively discuss common mistakes, such as writing /ɑ/ for /a/ or /ʎ/ for /ʎ/. I also walk around the classroom while they create the boards to make sure that they are accurate.

m	n	ɲ	p	b	t	d	k
g	f	θ	s	ʃ	ʒ	ʝ	x
χ	h	tʃ	dʒ	β	ð	ɣ	r
ɾ	l	ʎ	i	e	a	o	u

Figure 1. Gameboard for IPA Battleship

Once students have created their gameboard, they need to place their ships by circling groups of symbols. They should have two ships that take up two squares and another two ships that take up three squares in a line. These can be placed vertically or horizontally, but not diagonally. I project a possible arrangement on the screen (Figure 2), but remind them that this should be different for each person. In my experience, including both a visual model and verbal instructions helps reduce the number of confused students.

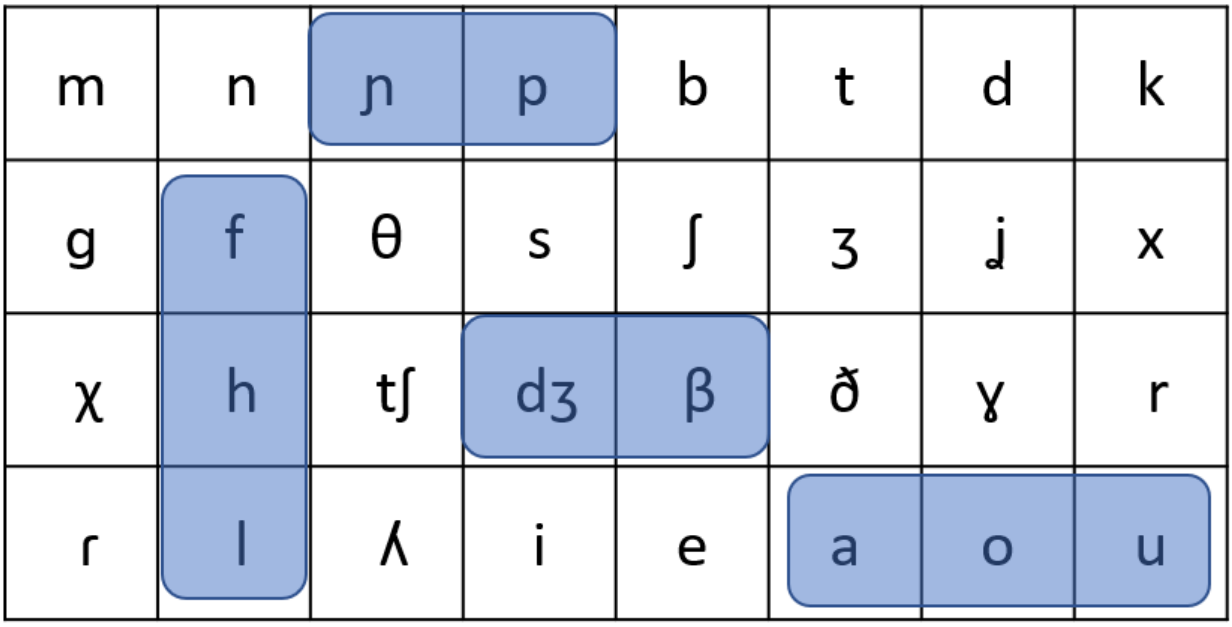

Figure 2. Sample ship placement in IPA Battleship

I also do this when I explain how to play the game. I model an example turn for them, where one person asks if their partner's ship is on [s] by saying its phonetic description. Since students are playing the game in Spanish, I think it is especially important to draw their attention to the correct word order for descriptions, which is manner of articulation, place of articulation, then voicing (e.g., *fricativa alveolar sorda* 'voiceless alveolar fricative'). Similarly, I make sure they know what to say to their partner in Spanish if that person missed their ships (*agua* 'water'), found one of their ships (*toque* 'hit'), or sunk one of their ships (*hundido* 'sunken'). Once one person sinks all of their partners' battleships, they win.

While they are playing, I project not only the instructions on how to play, but also an IPA chart of consonants that contains only the symbols that are relevant for the game, as well as a separate table for vowels. I also include a reminder note that consonants on the left side of a column in the IPA chart are voiceless, and those on the right side are voiced. This scaffolding is important to include because students will need this information to successfully play the game, but they are still working on memorizing it. In addition, making this information accessible keeps them playing correctly by using the phonetic descriptions instead of resorting to names of letters or other descriptive words. Walking around the room and checking that they know how to play also helps keep them on track and is a good way to see which symbols they struggle with.

I have used IPA Battleship with numerous classes, and overall students seem to enjoy it. Playing this game makes it clear to them that they still need to work on memorizing the phonetic symbols and descriptions, but this mental work is couched in a low stakes and fun activity. Depending on how quickly the students find each others' ships, they are likely to hear or say the description for the majority of the 32 phonetic symbols, which would be a much more boring process in a traditional review activity. As a wrap-up after everyone has finished, I ask each group who won, then I point to each symbol on the screen and have students say the description as well as pronounce the sound it refers to. This drives home the information that was practiced during the game and provides a brief review of the sounds. The materials for this game are available at https://www.ddaidone.com/teaching.html.

3. Case study #2: IPA Discard by Nathan Sanders

I have used IPA Bingo in every iteration of my own introductory linguistics courses at four different institutions in North America. Students have often reported to me that it was a highlight of the course. I recently began teaching a phonetics course, and a core learning outcome in that course is for the students to become familiar with the entire set of IPA symbols, which goes beyond what is available in the original IPA Bingo. I decided to use IPA Bingo early in the semester to help students learn an initial subset of the IPA needed for North American English. Later in the course, students are expected to learn the rest of the IPA, and given the success I had had with IPA Bingo in my introductory course, I wanted to use more games to help students learn these additional symbols, too.

However, rather than reconfiguring IPA Bingo with a different set of symbols, I decided to design new games with completely different gameplay that would make more meaningful use of the underlying structure of the IPA itself. I thought using game structures that connect more directly to the structure of the IPA might make for a more engaging experience for the students, especially those who are game enthusiasts. For the vowels, I designed a game called IPA Hunt, similar in basic concept to Daidone's IPA Battleship game described in Section 2, but with vowels laid out in the same pattern as in the IPA vowel chart (IPA Hunt is available on my website at http://sanders.phonologist.org/Papers/ipa-hunt.pdf and not described in detail here). For the consonants, I created a game called IPA Discard, which draws inspiration from card games in which cards can match each other for either number or suit, paralleling how consonants

can match each other for either place or manner of articulation (among other properties). This kind of multidimensional matching is a key feature of the Crazy Eights family of shedding games, which includes Mao and the proprietary game Uno.

In this family of games, players attempt to be the first to discard all of the cards in their hand. Each discarded card must match the number or suit of the active card (the most recently discarded card). For example, if the active card were the three of diamonds, then the active player could discard any card with either a three as its number or a diamond as its suit, such as the three of spades or the queen of diamonds. This newly discarded card then becomes the new active card and must be matched by the next player's discarded card. A player who is unable to discard a card to match the active card normally has to draw one or more cards, depending on the rules of the specific game. Some games in this family also have additional cards with special properties, such as wild cards that can match any card or action cards that may change the game state in different ways (forcing the next player to draw cards instead of getting an opportunity to discard, reversing the direction of gameplay, etc.).

This family of games is a natural fit for the IPA, given that IPA symbols represent phones with multiple different possible values from a small set of phonetic properties, analogous to suit and number for standard playing cards. I designed IPA Discard with place and manner of articulation for consonants as the matching properties, though other properties could have been used. A player may discard a card if its IPA symbol represents a consonant that matches the place or manner of the consonant represented by the IPA symbol on the active card. For example, if the active card has the symbol [ɴ], then a player may discard a card with a symbol representing any other uvular consonant (such as [q] or [χ]) or any other nasal stop (such as [ɱ] or [ɳ]). If the player is unable to discard a matching card, they must draw a card from the draw pile. The full rules for IPA Discard are available at http://sanders.phonologist.org/Papers/ipa-discard-rules.pdf.

The version of the game I designed has 90 cards, 62 of which are unique cards with symbols from the IPA representing consonants beyond those I normally teach for North American English, including both pulmonic and non-pulmonic consonants. The remaining 28 cards are designed to help balance the game so that gameplay is smoother and more enjoyable for the students. These 28 cards include 12 wild cards, which may be played instead of a regular card. Each wild card has two IPA symbols, and the player playing the wild card must choose one

of the two to be the new active symbol for the next player to match. The final 16 cards are duplicates of some of the base 62 cards, because some phonetic categories do not have enough symbols for balanced gameplay. There is one additional copy for each of [ɱ], [ⱱ], [ʈ̪], [ɖ̪], [ǀ], [ʔ], [ʜ], and [ʢ], and two additional copies for each of [ɕ], [ʑ], [ħ], and [ʕ].

The full set of cards (including 15 blanks for instructors and students to create their own cards) is available at http://sanders.phonologist.org/Papers/ipa-discard-cards.pdf. A few sample cards are shown in Figure 3.

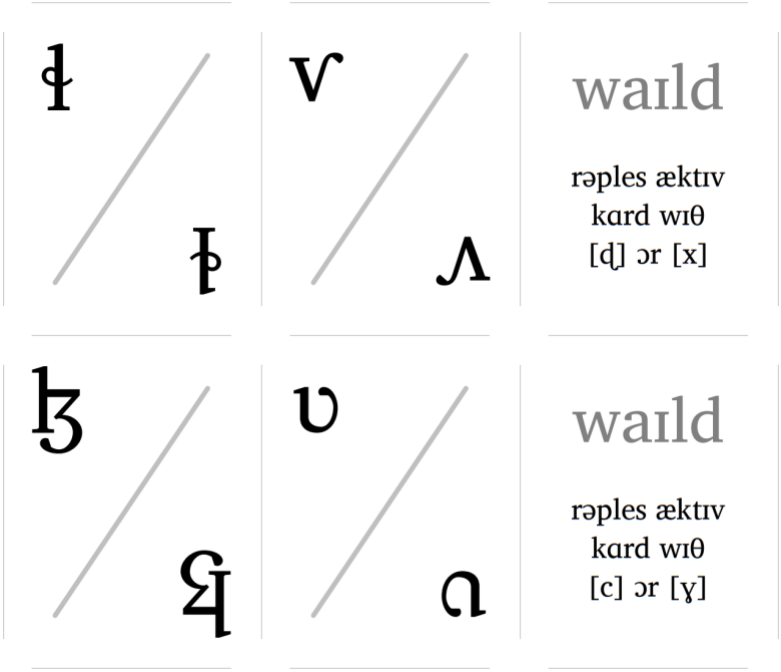

Figure 3. Sample cards from IPA Discard

I have found that this game works best with groups of about four or five students, though it is flexible enough to scale well with more or fewer players. My phonetics course meets once a week in a single large lecture with all 140 students, with a second class meeting held by teaching assistants (TAs) in four smaller tutorial sections with 35 students each. For these tutorials, I have the TAs assemble seven decks of cards so that they can divide their students into seven groups of five, with each group getting one deck of cards. After the TA explains the rules, the students can then play the game for a few rounds. Although the students are encouraged to play without looking at their notes, they are explicitly allowed to look if they need to. I also provide links to

the online version of the cards so that students can print their own copies at home. Depending on availability of resources, winning students may also be given the deck used in class as a prize.

Feedback from students and TAs has been extremely positive for this game. Students report that it was not just a useful memory aid but that it was also fun: they wanted to play it as a game beyond its utility for studying the course material. I have even seen students from our linguistics undergraduate student group playing it in our common lounge area, including students who were not in my course, showing that the game had spread.

4. Case study #3: Matching games by Nathan Sanders

During the COVID-19 pandemic, online educational tools suddenly became an urgent priority for many instructors. However, most of us did not have the relevant expertise to design and code these tools ourselves, so we turned to pre-existing resources that were quick and easy to adapt to our course content. In the summer of 2020, I was planning for a purely online version of my phonetics course, which meant I could not use my usual print-and-play games, such as IPA Bingo, IPA Hunt, and IPA Discard. So I searched for online alternatives and came across Steve Fortna's website Flippity, which perfectly suited my needs.

Flippity contains many different templates for online games, as well as other gamification tools such as badge trackers and leaderboards. Many of the game templates are integrated with Google sheets, allowing the user to customize them behind the scenes within a spreadsheet. One of the most effective game templates for my purposes on Flippity is the Flippity Matching Game, which is similar in play to the game Concentration. In these games, a deck of cards is laid out in a tableau, and players must select two cards that match (for example, a word and its definition or an IPA symbol and its phonetic description). If the two selected cards match, they are cleared from the board. If they do not match, they remain.

This style of game works well in breakout groups in online settings. The students can be randomized into groups of about four or five, and then one student shares their screen showing the game. Students can then work together to clear the board. For many of the games I designed in this series, there are two versions, an easy version with the cards face up and a harder version with the cards face down. In the hard version, the pair of selected cards are revealed, and if they do not match, they remain on the table but are flipped back over to hide their values. This adds an extra challenge of having to remember where on the board the unsuccessful matches are.

The following are links to two of the matching games I designed. The first is an open match game for IPA vowel symbols, with the cards face up, and the second is for the harder memory match game, with the cards face down (this is the standard way that Concentration is played).

https://www.flippity.net/mg.php?k=1cQCJ4pKTjhZ9dZBkyu2U1W-6BHlpVeami-qTw1Cwf-I
https://www.flippity.net/mg.php?k=1szwX8Zs78dgbjL2A9ICDmKhMnD1eMhfvuiIvmoqGdi0

I also designed similar games for my phonology course for the second semester. For these games, I used phonological features and natural classes as the base. The following are links two open match games for phonological features:

https://www.flippity.net/mg.php?k=1gszhZDis1a-wn6II4WOeASHXSHSgGkOObT2LVf1C4X4
https://www.flippity.net/mg.php?k=16C6zjFHk5GCc9PIhX6yXTMP4jyXUJuwQTOu07sazukU

In the interest of fostering a sense of online community during the pandemic, I opted to design these online games as cooperative games. However, these matching games can be played competitively in a few ways. For example, students within a group may compete against each other by scoring points for each successful match they match (note that there is no built-in scoring functionality in the match games on Flippity, so players would have to keep track of scores themselves). Alternatively, Flippity provides a timer for the matching game, so students can race against the clock to add a bit of competition, either against some previously set standard or against the times from the other breakout groups.

As with IPA Discard, I received broad positive feedback from the students and the TAs. There were some glitches, however. Flippity would occasionally return server errors (likely due to increased demand in the early months of the pandemic), and a change in Google Sheets in August 2021 that rendered some of the games on Flippity inoperable, though the designer did a lot of work to update the games to accommodate the changes. This is one of the drawbacks to technology-based games, and it is important to have backup plans ready in case of technical issues. I was not prepared in the first semester of using these games in the pandemic, but I

learned a valuable lesson that semester and made sure that every online game I used in the future had some alternative activity prepared.

The games I have described in Sections 3 and 4, plus other games not described here, including an online version of IPA Bingo made with Flippity, are all available on my website at http://sanders.phonologist.org/lxgames.html.

5. Conclusion

We have presented here three different kinds of games for use in helping students to learn IPA symbols, phonological features, and natural classes. These games were adapted from or inspired by existing games (Battleship, Crazy Eights, and Concentration), which is useful both for the instructors (in not having to design a new set of game rules from scratch) and for students (since many may already be familiar with the rules). We have also offered games from a mix of modalities. Pencil and paper games, like Daidone's IPA Battleship, are perhaps the easiest to integrate directly into a course, since they require little setup and resources, and they give students a more tactile experience with practice drawing IPA symbols. Print and play games, like Sanders's IPA Discard, also provide for a tactile experience and can allow for greater rule complexity, though at the cost of requiring more initial labor on the part of the instructional team. Finally, even though online games, like Sanders's various Flippity matching games, lack a tactile experience, they still present some advantages over physical games, such as quick randomization of components and natural interaction in online environments. However, instructors without coding expertise will be limited to using existing online games and game templates, which may not always suit their needs. Regardless of modality, games are a great way to increase student engagement through low-stakes active learning activities, and we hope that the game options we have presented here will be helpful to instructors, whether through direct use or adaptation of our games or through inspiring instructors to create their own new games.

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