

# Affordances of Play for Student Agency and Student-Centered Pedagogy

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**Abstract.** While guided instruction can successfully focus students on concepts to be learned, this instructional approach can also reduce student agency and ownership of learning. Over the last two years, we have implemented PhET interactive computer simulations in middle school (MS) classrooms and found that “open play” can allow increased student agency and simultaneously lower barriers for student-centered pedagogy. In these MS classes, activities begin with 5-10 minutes of open play where students use the simulations without instruction. A moderately-guided, inquiry-based activity follows. In a study of classes with play versus no-play, we found that with play, the teacher focused on student ideas and science content, while without play the teacher employed more direct instruction.

**Keywords:** Computer simulations, play, physics education research, elementary school, middle school

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## INTRODUCTION

Play is an important, but often overlooked, aspect of what students do in school. Play is often viewed as the opposite of work. [1,2] Thus, it may be considered a distraction, or, at best, a break from the learning that happens in schools. However, play can be productive for a number of educational goals, including fostering student agency (i.e., their capacity to act in their own interest), enjoyment, and exploration, as well as developing content learning. In this paper, we will demonstrate productive use of play as a teaching strategy that supports a student-centered classroom environment.

Play is an active topic of research. According to Rieber [1] play includes the following attributes: 1) it is usually voluntary; 2) it is intrinsically motivating; and 3) it involves active engagement. Hawkins [2] describes play (which he equates to work) as “productive messing about”. In this sense, play is very much like what scientists do when approaching a new and unfamiliar problem or subject. “Messing about” can reveal the extent of the conceptual space for a given topic, which aspects and parameters are important, and which are not. Allowing children to mess about can lead to deeper and more meaningful exploration and learning, whereas giving specific instructions can limit exploration and result in surface level learning. [3]

Over the past two years, we have found that play can be an essential part of activities using computer simulations for middle school students. Teachers in the classes we have studied allow 5-10 minutes of open play with a simulation, followed by an inquiry-based worksheet activity. In this study, we examined

the effect of play more systematically in an experiment comparing a classroom where students get to play to one where they did not. The key finding from this experiment is that play appears to foster more student-centered pedagogy.

## CLASSROOM CONTEXT

The experiment was conducted in 5<sup>th</sup> grade classrooms in a charter school in Dallas, TX. The student body is 90% Latino, with many students of low socio-economic status. The science classes studied have about 20 students each and are mixed gender. For simulation activities, each student has their own laptop, but students work in pairs. Classrooms have a Smartboard, and desks are arranged in groups of four, with space for the teacher to roam the room. Students in these classes had used simulations before, generally with about 5-10 minutes of open play before starting a written activity. The teacher sets up this part of the activity by having students open the simulation and play without further instructions. The teacher roams the room watching students, intervening only to ask what students are doing and sometimes pointing out if a student has done something interesting. We have observed that students share many ideas with each other during this time, often walking to other students’ computers to see what they are doing. Ideas and ways of using the sim often “go viral” throughout the room once one or two students have found a control or interesting sim feature.

In these classes, the teacher often has a student go to the Smartboard to demonstrate something the student has figured out, or some aspect of the

activity. During this time, the teacher may ask this student questions as well as questions to the class.

The classes involved in this study focused on light reflection and refraction. The teacher began the class with students in one large group in a corner of the room, discussing how light reflects off of some objects, such as metallic surfaces, and refracts through water. Students had glasses of water and observed how objects inside the glass appeared to be displaced from their actual location. This introduction to the lesson lasted about 10 minutes. Students then returned to their desks to begin the simulation part of the lesson, using *Bending Light*.

## SIMULATION

*Bending Light* covers reflection and refraction, a 5<sup>th</sup> grade learning objective. The sim can be found at [phet.colorado.edu](http://phet.colorado.edu). Figure 1 shows Tab 1. Sim users can shine a laser into media with different indices of refraction. The laser can be rotated to change the angle of incidence. Light can be viewed as a ray or wave. The index of refraction can be changed by selecting different media (e.g., air or water), or by moving a slider. Tools include a protractor and an intensity meter. Tab 2 allows students to use prisms of different shapes. Users can change the wavelength of monochromatic light, or select white light and use the prisms to make rainbows. Tab 3 includes additional tools such as a speed meter.

## METHODS

Our experiment involved two classes on the same day. One class began with 8 minutes of open play as usual. A second class had no play, beginning with the written activity immediately. The teacher framed this activity by telling the class that they would “start right off on our learning objectives.”

Data collected included video recording of the classroom and screen capture for student laptops in

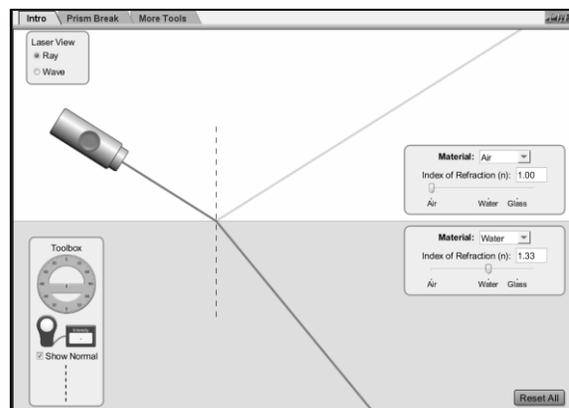


Figure 1. Bending light simulation

the *Play* (N=8) and the *No-play* classes (N=5). We use Camtasia screen capture software. The screen capture records video of each laptop screen and audio through the laptop’s microphone. This allows us to see exactly what each student does with the sim and single out the verbalizations of students near each laptop. The classroom video allows us to capture the teacher’s actions as well as a broad view of the students.

By using the screen capture and classroom video, we can code student and teacher actions and utterances. Codes were assigned at 15 second time intervals. Some intervals had multiple codes.

We coded teacher utterances into the categories shown in Table 1. We consider Teacher Open Questions (TOQ) to be indicators of *student-centered* pedagogy, while Teacher Instructs Class (TIC) indicates *teacher-centered* pedagogy. We code the total number of TOQ and TIC utterances in each 15 second interval.

For students with screen capture data, we coded the percentage of these students using sim elements in each 15 second interval. For instance, if 6 out of 8 *Play* students used the sim in a 15 second interval, this was coded as 75%. We also coded when a student was at the Smartboard to show the times when the class had the opportunity to engage with a student-led demonstration at the board.

TABLE 1. Teacher utterance coding scheme.

Code	Description	Example Statements
Teacher Open Question (TOQ)	Teacher asks an open question to a group of students or entire class, or asks one student during whole-class discussion.	"As our light ray moves through different materials, what can we do to that light ray?"  "What can we do, Stephanie, as we change the materials? What happens to the light ray?"
Teacher Instructs Class (TIC)	Teacher lectures, directs, or gives an instruction to the entire class	"So the things that you should have filled out now are the index of refraction, in the first material, the index of refraction in the second material, and now you should have the intensity of the light being reflected."  "Very good, so go ahead and label the intensity of the light."

## RESULTS

Figure 1 shows the teacher and student codes for the *Play* and *No-play* classes. In the *Play* class, the first 8 minutes were spent on open play, with the remaining 40 minutes spent on the written activity. In the *No-play* class, 37 minutes were spent on the written activity.

For the *Play* class, there is significant (and increasing) student sim usage with almost no teacher intervention for the first 8 minutes, with most or all students using the sim in each interval. These students are allowed to explore with very little guidance. The teacher then begins to lead the class using more student-centered than teacher-centered utterances. During the teacher led period, student sim use is substantially reduced, although not zero. Students are continuing to use the sim while following the teacher and, sometimes, following the student at the Smartboard. At 19:15 the teacher allows students to work at their own pace. For the remainder of the class, student sim use increases and remains fairly high, while the teacher utterances are fairly infrequent. Video from this class show students engaged with the simulation while the teacher spent the majority of time roaming the room and watching students with few direct interactions.

For the *No-play* class, the teacher begins immediately with teacher-centered utterances. During the teacher led period of this class, student sim usage is high early on, but drops to less than 60% for the majority of this time. After 19 minutes, students are allowed to work on their own, and sim use rises slightly.

Video from this class indicates a great deal of difficulty for the students using the sim, and for the teacher leading a discussion about the concepts. Students had many questions about how to use the sim, and the teacher frequently needed to stop the class for direct instruction.

We compiled the time-series data into single factors indicating overall student- vs. teacher-centered focus (Table 2). We analyzed the *Teacher Led Periods* in each class, when the teacher has the most explicit influence. During these times, the *No-play* class had a larger number of both student- and teacher-centered utterances compared to the *Play* class. However, the *No-play* class spent more time with the teacher leading ( $\Delta t_{No-play}=19$  min.) than the *Play* class ( $\Delta t_{Play}=11.25$  min.) We accounted for this time difference by taking the time average over each teacher led period. The results indicated a significant effect on teacher- vs. student-centered utterances with the *Play* condition being proportionally more

student-centered ( $\chi^2$ ,  $p=0.02$ ). We generated a statistic, the *Student-Centeredness Ratio*, which is the time-average ratio of student-centered to teacher-centered utterances. A ratio of 1 would indicate an equal balance between student- and teacher-centered utterances. The *Play* class had a substantially higher ratio (1.22) than *No-play* (0.63).

## CONCLUSION

In this study, we examined the affordances of play for student agency and support of student-centered pedagogy during a simulation-based classroom activity. In this case, we found that a short amount of play at the beginning of class led to a more student-centered, inquiry-based classroom. Play appears to familiarize students with the simulation and provides students with sense of autonomy. Observations suggest that teacher facilitation can then focus more on science ideas – drawing out student-discovered ideas, posing hypotheses for testing by students – and less on instructions about how to use the simulation.

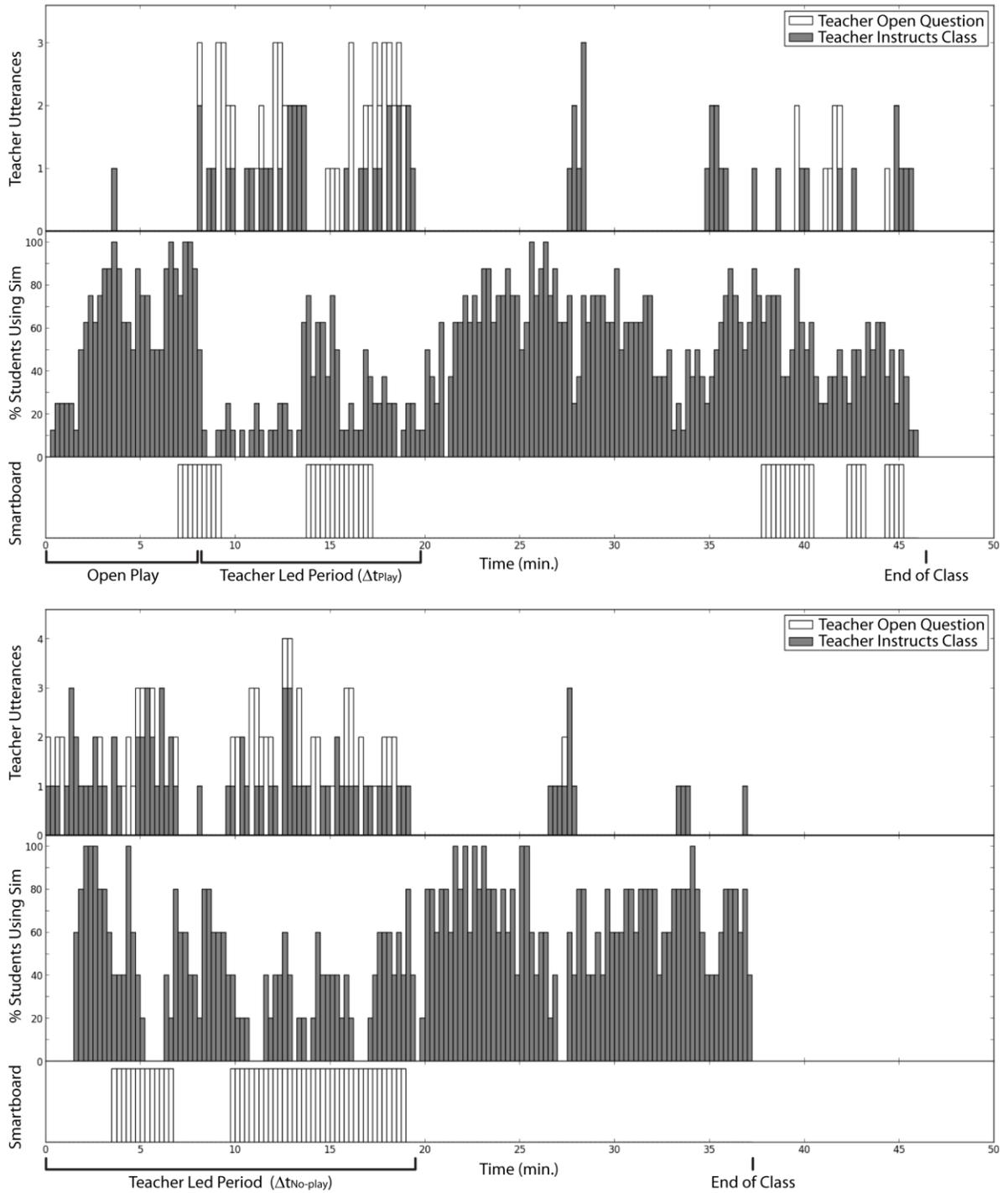
A pedagogical approach incorporating play, as employed in the *Play* group, can strike a balance between complete student autonomy, which may not focus enough on specific learning objectives, and direct instruction, which may reduce deep student engagement and have negative affective consequences for students. Even a few minutes of play in a lesson appears to have positive affective results for students. Teachers tell us that students enjoy using the simulations when they develop a sense of ownership over their learning through play. Students say that they enjoy and strongly value play time, but that they also value the more guided parts of lessons that focus on specific learning objectives.

## ACKNOWLEDGMENTS

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**FIGURE 2.** Teacher and student codes vs time for the *Play* (top) and *No-play* (bottom) classes. Codes are for 15 sec. intervals.

**TABLE 2.** Data from teacher utterance coding.

Class	Teacher Centered (TIC)	Student Centered (TOQ)	Teacher Centered Time Average	Student Centered Time Average	Student Centeredness Ratio (Time Average)
Play	32	39	2.8	3.5	1.22
No Play	72	45	3.8	2.4	0.63