



Board Game Development as a Pedagogical Approach to Teaching Undergraduate Students in an Interdisciplinary Course that Addresses Contemporary Societal Issues

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Introduction

Note: This paper is about a work in progress.

Positively engaging students and facilitating meaningful content connections in the classroom is vital to successful learning [1, 2]. Specific to undergraduate education in modern times, this engagement is not a one-size-fits-all approach. Instead, it is perhaps characterized by more open-ended learning experiences that promote discovery and the formation of learning associations across a spectrum of content areas [3].

Board games are extremely popular amongst younger generations with annual sales topping \$9 billion [4]. It has been theorized in the literature that board games are an ideal medium for teaching course content as it helps to form a common language between instructors and students [5]. Similar to the scientific method, observations that players make during the game will guide their interpretations and resulting decision making that hopefully leads to increased efficiency and player advantage. Frequently, studies have sought to examine board game play as a teaching tool for science [5, 6, 7, 8] and it was thought that experiencing this tool firsthand could provide the course professors with knowledge of its merits and limitations.

Characterization of the paper

This paper reports the development and implementation of a new course that utilized board game play, deconstruction, and design together as a novel pedagogical approach, and discusses the evaluation results to provide insight on the approach. This course and its evaluation were meant to be exploratory and serve to provide a first-glance at a potentially promising instructional technique. The research presented could potentially be considered akin to *action research* though not formally so. As it is exploratory and in the early stages of development, it has not yet been situated in the literature or within any broader educational frameworks. It has also not been formally compared to other teaching methods at this stage of the exploratory process. The evaluation of this course and its delivery made use of self-report surveys filled by the students and the authors acknowledge the limitations of this approach. While surveys can provide insightful, reliable, and valid data, the results yielded from them would need to be cautiously interpreted to avoid making erroneous conclusions [9]. More typical measures of student performance (i.e., tests) were not given to students. Instead, student performance was explored from the perspectives of the students via survey questions. As such, the authors make no claims as to the actual effectiveness of the methods used in terms of student performance. All data provided are meant to illustrate our experience with the approach to the course. The research presented could be significant in that it (a) informs other practitioners about an approach to using board game play, deconstruction, and design as an instructional tool, and (b) it could guide further explorations of the method, either by these authors or other researchers.

Description of the pedagogical approach and assessment methods

A new interdisciplinary team-taught course was developed by the Departments of Earth Sciences and Mechanical Engineering at the authors' university employer that explored board game deconstruction and development as a pedagogical method to engage undergraduate honors

students. To this end, a one semester curriculum was devised and taught to students in the Fall academic semester of 2019. Students were taught scientific content related to climate change and its potential impacts on a variety of former civilizations including the Maya, the Mongols, and the Ancestral Puebloans. Students were asked to extrapolate lessons learned from these past events to consider how climate change may affect societies today. Board game design mechanics were also taught via weekly board game sessions conducted inside and outside of class where students both played and deconstructed the mechanics of the games experienced. In the latter part of the course, a major course project was assigned in which four teams of students in conjunction with graphic design students developed unique games meant to teach others about climate change and civilization collapse. Specific game mechanics were not prescribed; instead, student teams were encouraged to explore a variety of mechanics and design elements that best suited their chosen audience and game theme. In addition to this final board game product, students wrote a reflective paper to (a) explain how the board game accomplished the goal of teaching its target audience about climate change and/or civilization collapse, and (b) what the students felt they learned by being asked to create a final board game product for the course compared to a more traditional means of assessment such as a final exam. The pedagogical approach was designed to be a multifaceted and immersive experience to facilitate student engagement. In pursuit of this objective, a field trip was taken to tour the Cahokia Mounds Historic Site, an example of an ancient collapsed civilization in the United States. Weekly readings in the textbooks *The Great Warming: Climate Change and The Rise and Fall of Civilizations* by Brian Fagan and *1177 B.C.: The Year Civilization Collapsed* by Eric Cline were assigned and subsequently discussed in class.

The objective of the final board game project was for student groups to create a fully functioning board game that would teach about climate change and civilization collapse. This final project made with the assistance of graphic design students from the College of Fine Arts, required that each group turn in a completed game that was placed in a box with all of the required pieces. Each group had to write and submit a well-written rule book that could be used to teach someone how to play the game. The final paper portion of the assignment was meant for students to communicate how they thought their board game accomplished the goal of educating their target audience about climate change. Also, it was asked that students write about what they felt they gained from the board game creation process compared to studying for a traditional final exam.

In order to provide a succinct understanding of what the students were working towards in this class, the three stated objectives from the course syllabus are included here:

- 1. Understand the boundary conditions that drive the climate system*
- 2. Critically think about what role climate change has played in the collapse of past civilizations, and how it may cause future “civilizations” to collapse.*
- 3. Take gained knowledge from the course and show collaboration and teamwork to apply to the design and creation of a board game to teach your target audience what you have learned.*

Since the class was run through the Honors program, the 16 students who enrolled in the course represented a cross-section of university programs and were not just engineering or science students. Students reported that their major was located in the following colleges: Arts and Sciences ($n = 7$), Engineering ($n = 5$), Business ($n = 2$), Agriculture and Human Ecology ($n = 1$), and Music and Fine Arts ($n = 1$). Of those who reported, their classification is as follows:

Table 1. Crosstabulation of Student Gender and College Major

	Male	Female	Total
Engineering	4	1	5
Arts and Sciences	2	5	7
Business	1	1	2
Agriculture & Human Ecology	0	1	1
Music & Fine Arts	0	1	1
Total	7	9	16

Sophomore ($n = 2$), Junior ($n = 6$), Senior ($n = 7$). The class was made up of seven males and nine females. Table 1 shows a cross tabulation of major by gender.

Evaluation of the pedagogical approach used in this course was conducted holistically by two researchers from the College of Education. Two survey instruments were used and administered electronically via Qualtrics. One comprehensive survey was given at the end of the semester. It was comprised of 16 closed-ended response options, and two open-ended questions about (a) the best parts of the course and (b) what needed improving according to the students. The constructs measured were content knowledge, teamwork, and instructional strategies. The other survey instrument was administered before and after the content of the course was taught in September and December, respectively. Observations were conducted at least monthly to inform the researchers about the class meetings firsthand. Also, one day of approximately eight hours was spent playing the student-produced board games with the course professors. The first-hand information gained from the reflective papers was also analyzed using thematic analysis and included in the findings presented in this paper. Presented in the following sections are some of the results of the surveys and first-hand information from the reflective papers that are informative to the understandings sought by the researchers and course creators.

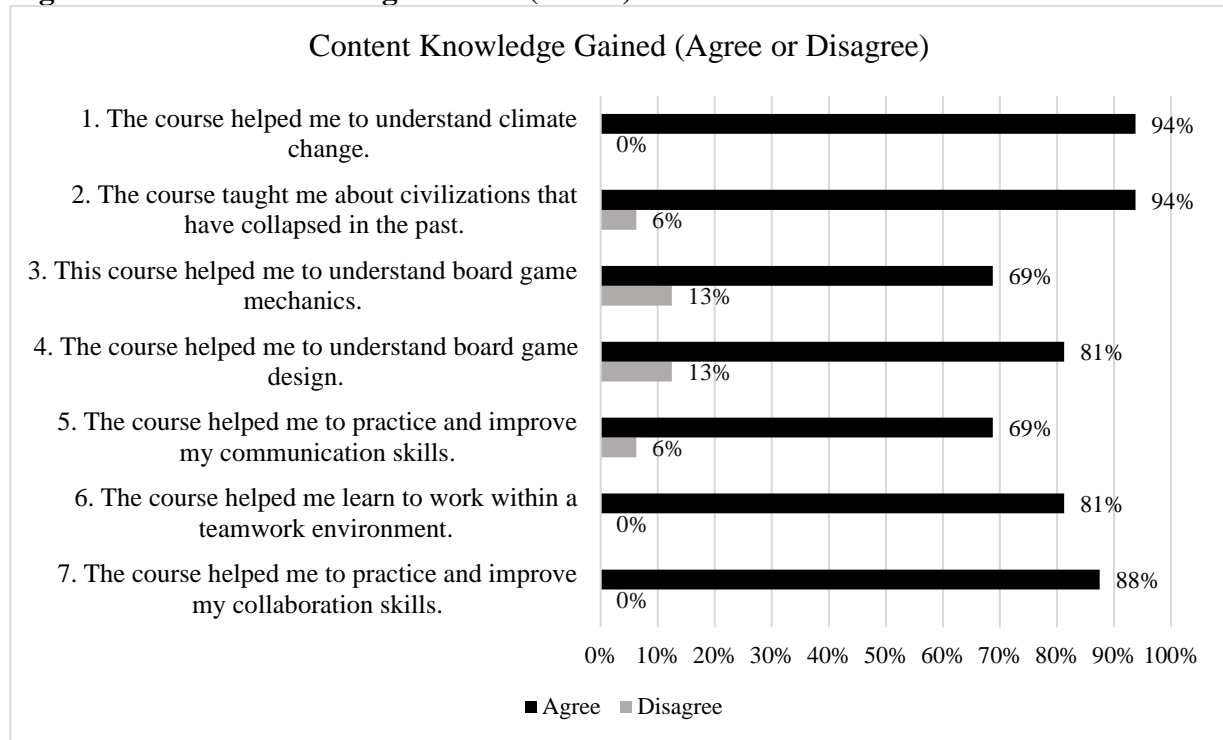
Survey data and discussion: findings from the course evaluation

Content knowledge

The survey item shown in Figure 1 was part of the comprehensive instrument administered at the end of the course where students were asked about their perception of the knowledge they gained through participation in the course. Displayed are the first series of statements where students were asked about their level of agreement with statements related to content knowledge. They were also given the option to not respond or to neither agree nor disagree in order to mitigate bias. Figure 1 shows the combined disagree and agree response (strongly or somewhat) totals. The majority reported that the course helped them across all items included. The largest percentages of agreement were seen for items one and two (94%) which seems to indicate that the students perceived the course to be successful in meeting its primary objectives concerning an increased understanding of climate change and collapsed civilizations of the past. It should be noted that this particular block of questions did not ask exclusively about the final board game project so this acquired content knowledge could be the result of any instructional methods used (singular or in combination).

The next survey item on the comprehensive survey (Figure 2) is a group of statements focused on the students' understandings and knowledge of central course concepts. Presented in Figure 2 are the top-two response options for both the pretest and posttest. Larger percentages of students reported a proficient or advanced understanding on the posttest compared to the pretest. This

Figure 1. Content Knowledge Gained ($n = 16$)



increase could be due to any of the teaching strategies employed and indicates that the course was effective at teaching content according to the students.

The pretest and posttest survey item presented in Figure 3 consisted of statements with a closed binary response option (*yes* or *no*). This survey item was meant to ask students about their perceptions of their content knowledge before and after the course. Positive (*yes*) responses increased from the pretest to posttest on all statements except one. Similar to the findings presented in the survey items shown in Figure 1 and Figure 2, this suggests that the course was effective at teaching the intended content.

The final board game project

Shown in Figure 4 are the results of the comprehensive survey item that asked students about their perceptions of the final paper and board game project. The survey items with the highest percentage of agreeance were numbers two and four (56%). More than half of the students indicated the final project helped them to (i) *critically think about what role climate change has played in the collapse of past civilizations* and (ii) *understand how scientists reconstruct climate records from the past*.

Instructional strategies

Figure 2. Pretest and Posttest Understanding ($n = 16$)

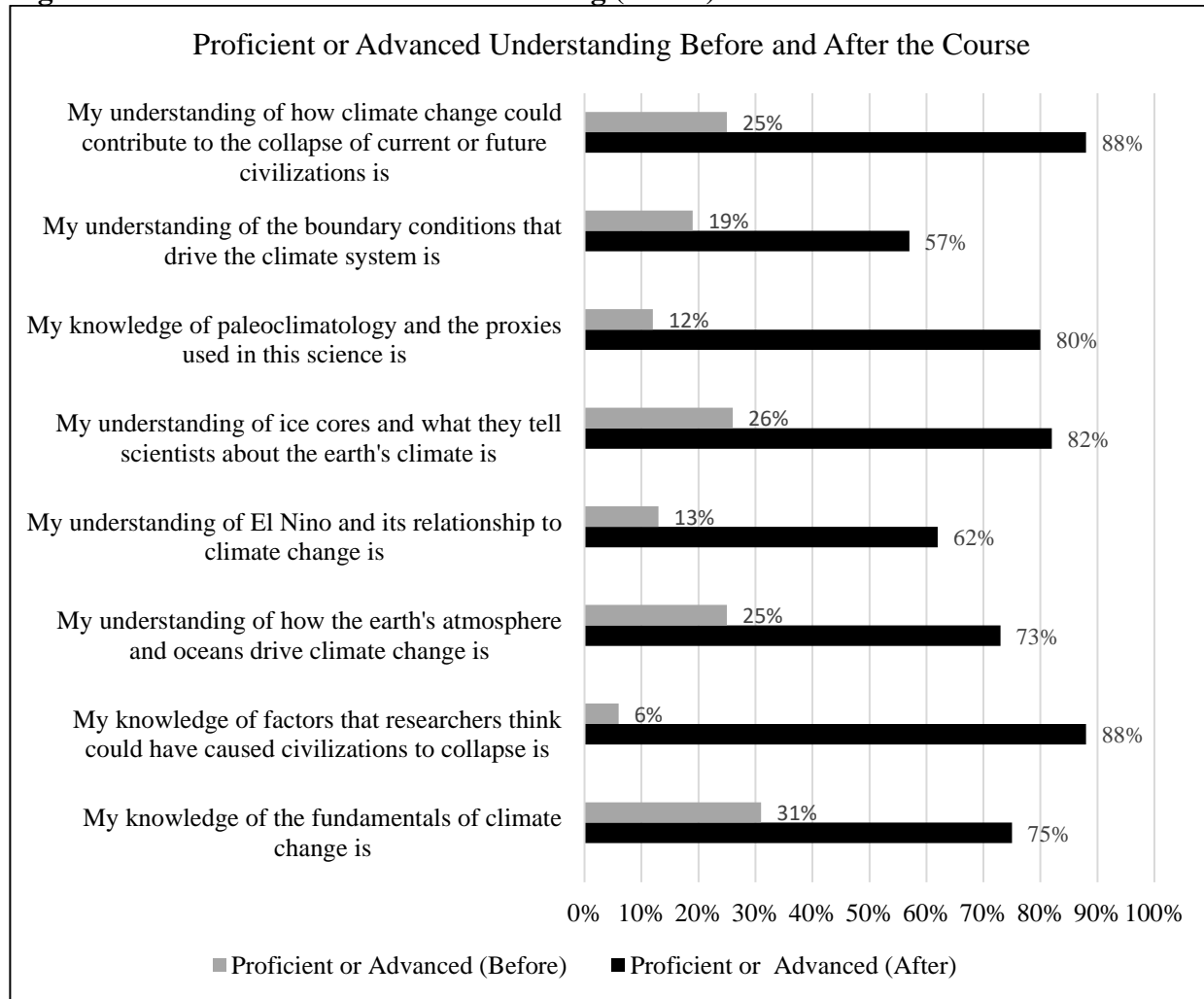
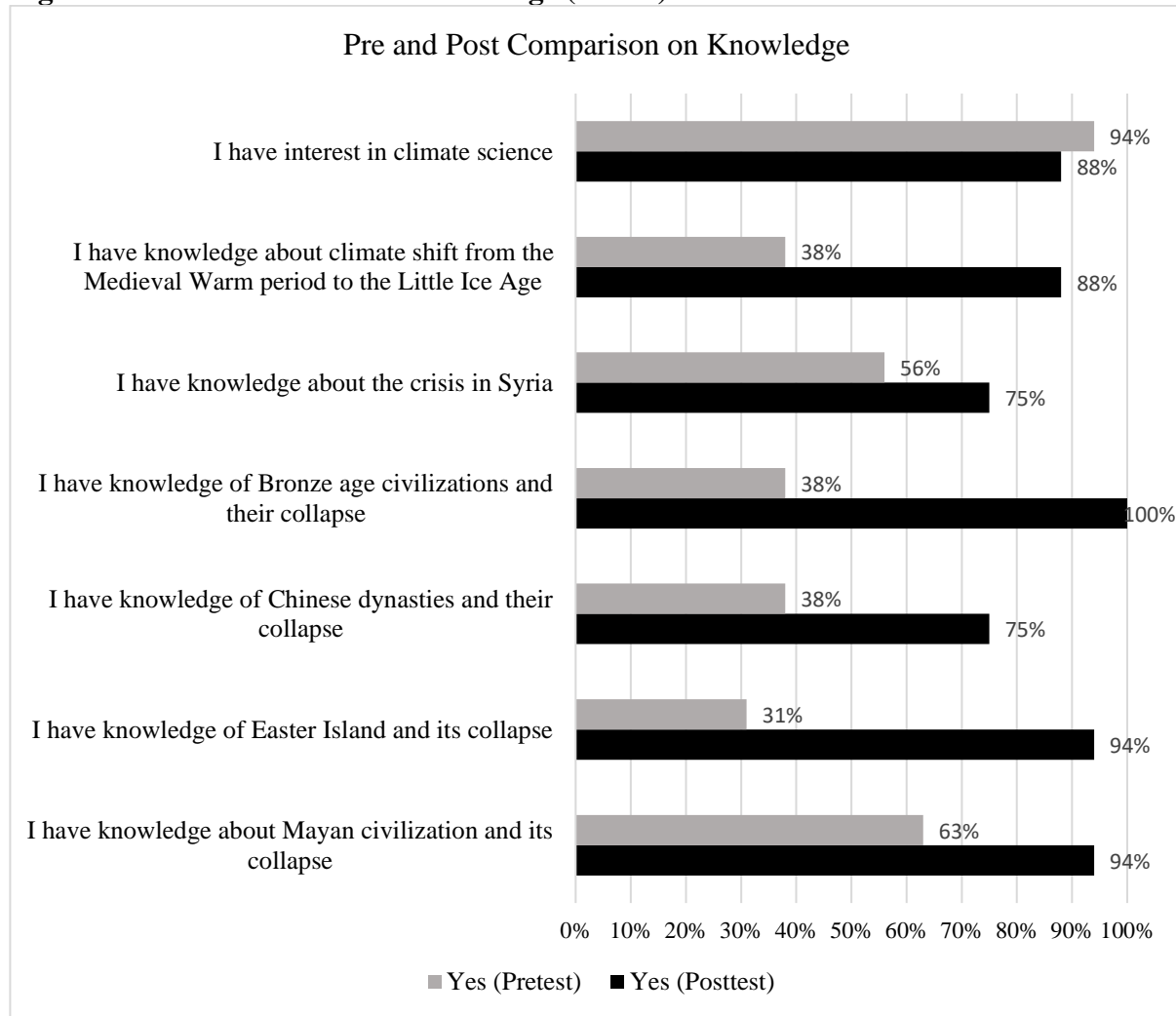


Figure 5 shows a comparison of seven different instructional methods used during the course. Students indicated that the most beneficial strategies were class discussion and lecture while the strategies that incorporated board game play were viewed as beneficial, but not quite as much as the top-two. This could be for a variety of reasons such as the uniqueness of the experience of learning with board games compared to more traditional methods. Asked about their level of engagement with the final board game project, the majority of students (70%) indicated that they were highly engaged.

Best aspects of the course – final project

Students were asked about what they perceived to be the best parts of the course. Many of the commenters mentioned the board game aspect of the course as being their favorite part. This perhaps speaks to the broad appeal of board games and their potential as an educational method. Particularly revealing was the comment where the student indicated that learning with board games helped them be more open to the course content as it helped reduce stress via its hands-on nature. Some of the insightful responses are bulleted below.

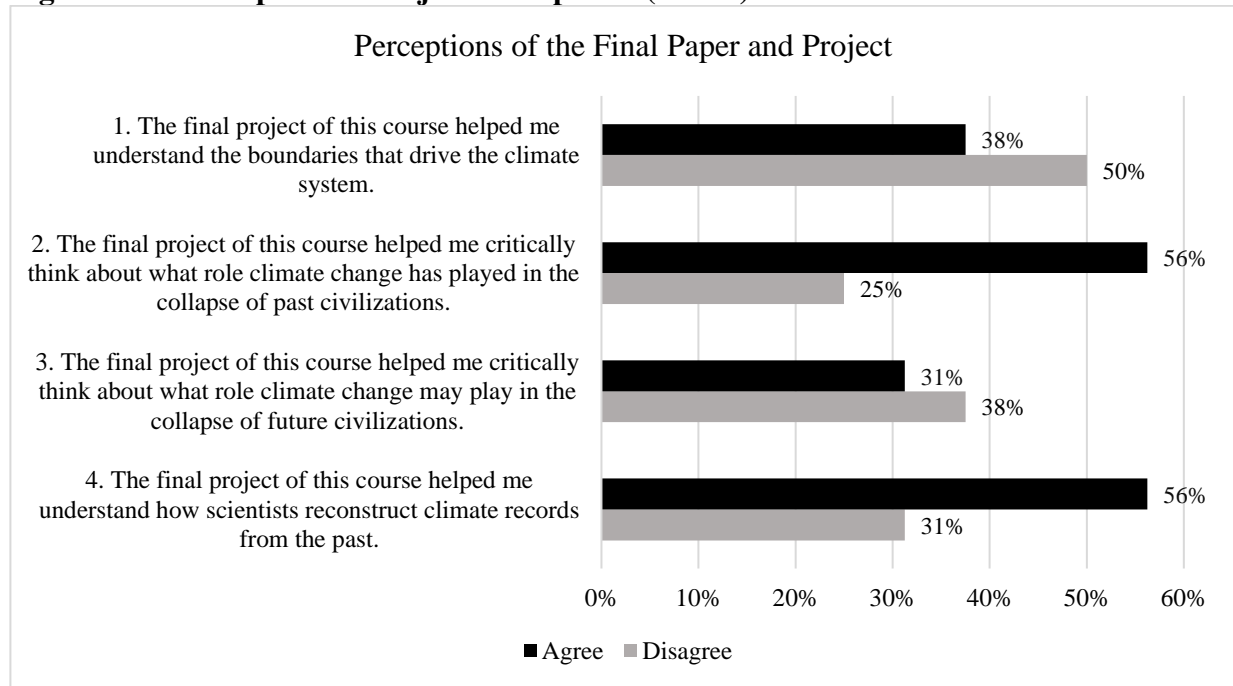
Figure 3. Pretest and Posttest Knowledge ($n = 16$)



- *The best aspects of the course, in my opinion, were the sessions in which we were able to spend a lot of good time playing board games, and then re-convening and discussing these mechanics in detail and analyzing what they brought to the gameplay...*
- *One of the best aspects of the course was learning about the different board games that I had never played before. Before this class, I had really only played board games that were quite basic, and known by almost everyone. However, through this class, I learned of several other board games which I had never played which I enjoyed...*
- *...I really enjoyed the board game element, obviously, as it not only exposed me to more games, but it also gave me a lot of confidence in the fact that I can say I created a board game in this way. The moment I noticed how the concepts we were learning in class connected to a board game idea I had was SUPER exciting. This content is not something I have ever truly cared about or been interested in, and if the final or any other assignments had not been so hands-on, I would have undoubtedly been a lot more stressed and a lot less open to accepting the content presented...*

Suggestions for improving the course

Figure 4. Final Paper and Project Perceptions (n = 16)



In contrast to the positive sentiments expressed about the board game creation aspect of the course are the following comments made about what could be improved.

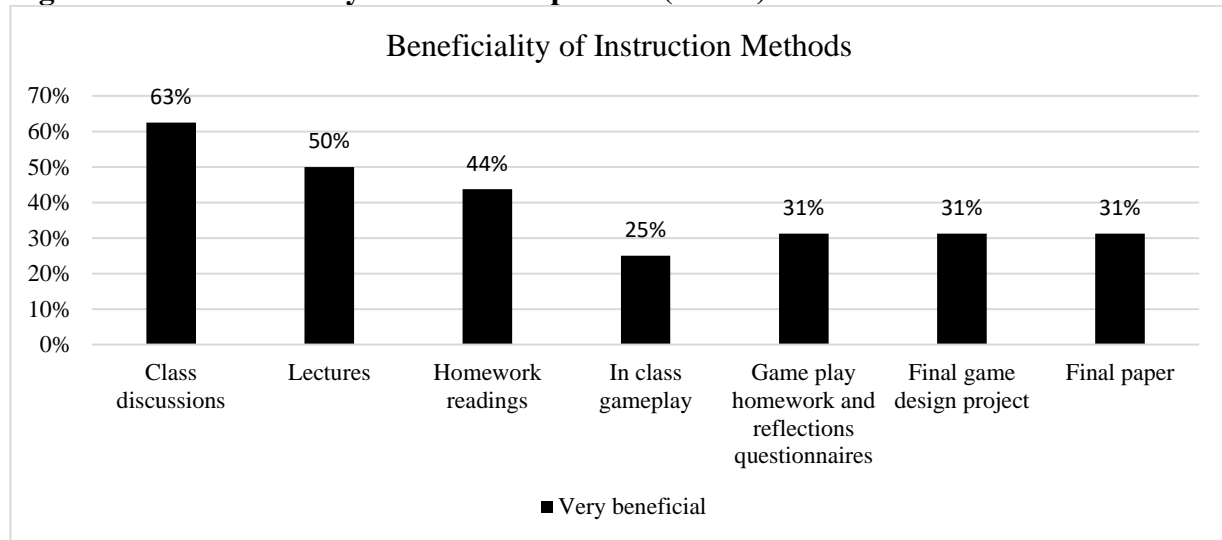
- *I believe the board games we made could have taught content more if we had started to create them earlier in the semester as well, having more time to change and adapt them rather than rushing to create something that made a little bit of sense.*
- *I feel as though other groups who were not a part of our project should not get to peer evaluate us since they may develop a bias for a how a board game “should be” because of their own designs.*
- *More focus on proper board game design. Proper allocation of time and resources to both aspects of the class (read: more time for board game design and the final project)*

Students’ reflections

The selected responses below are in response to the following question they were asked to address on their final reflective paper: “*How does your target audience learn about the effects of climate change and/or the collapse of civilizations through playing your game?*” These insightful responses show that students were making connections between the content of the course and the board game creation process.

- *Perhaps my personal favorite element of the game is connected with its very nature and purpose: cooperation. This game could have easily been adjusted to become competitive, in which each resource is racing against the others to save their civilization first, perhaps even through sabotaging opponents. However, while civilizations did indeed clash and will undoubtedly continue to, this is not the lesson we are hoping to communicate. Rather, it was our hope that [our game] shows the interconnectedness of civilizations and how relying on trading and working together can sometimes lead to the ultimate success,*

Figure 5. Course Delivery Method Comparison (n = 16)



while other times it still is not enough to combat the unpredictability of both climate and complexity.

- After playing this game our target audience will hopefully have a better understanding of the cause and effect relationship that climate can have on how a civilization survives. They should also have a better understanding of who the Mongols are and what their lifestyle was like... While working on the game I got a much better understanding of the different cause and effect relationships that climatic events can have on civilizations. When we were writing out scenarios for the cards in our game that show how this relationship can be damaging, helpful or neutral it really helped me fully understand the concept more.*
- Throughout the course of this class, the depth of my understanding in regards to the causes and ramifications of climate and climate change have been greatly expanded. While in most courses tests and quizzes are how “success” is valued, the designation of grading to be largely linked to the development of a game greatly enhances the ideas in my mind. Rather than studying in a pseudo-mindless manner for tests that cover extensive material only to forget the large majority of it within a few weeks, the necessary thinking and creativity which results from creating a game is much harder to forget. Indeed, there are many more positive memories and moments which can be associated with the production and play of a game than, say, a standard final exam.*

Conclusions

Board game-based instruction seems to be enjoyable for students. Incorporating board game creation into course teaching appears to be a promising way for students to engage with content in a way that they might not otherwise do. Genuine connections can potentially be formed between the course content and the learner when he or she feels responsible for a hands-on, functioning product created with a well-meaning purpose (i.e., to educate others about climate change). The promising illustrative data presented in this paper seems to point to further exploration being justified. Potential next steps for this research could be: (a) to take the class created games into an educational environment and measure their impact on their target audience, (b) to test students for content mastery and compare it with the results of other

instructional approaches, and (c) further situating the board game as a pedagogical approach in the relevant literature and educational frameworks to guide its development.

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