Location, Location, Location: The Effects of *Place* in Place-Based Simulations

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Abstract: Educators who develop and use place-based curricula argue that engaging students in authentic problem-based learning situated in students' own local place helps them understand the relevance of their academic work, which improves learning. However, while place-based curricula are localized, they are also authentic, problem-based experiences, which have been shown to be effective in their own right. Without controlling for the impact of authenticity, it is not clear whether localization itself improves student learning. In this study, we used a place-based simulation to engage students with authentic problem-based learning about a specific place: a city that is local for some students and not for others. We assessed differences in cognitive, affective, and behavioral outcomes between these two groups. Our results suggest that learning outcomes are better when students engage in a place-based simulation about their own locality, indicating that place does play a critical role in the success of place-based education.

Introduction

According to theories of *situated learning* (Brown, Collins, & Duguid, 1989), all learning occurs within a specific context. However, learning scientists have also argued that we should also consider how learning is situated, not just that it is situated (Greeno & Middle School Mathematics Through Applications Project Group, 1998). One application of situated learning is *place-based education* in which students learn by engaging in authentic problem-based activities about issues in their local community. When creating place-based curriculum, educators identify content and create localized activities using particular place attributes including the geography, history, social issues, environmental issues, and other specifics of that place. One reason educators may use this method is that research has shown that when students engage in place-based curriculum they show higher increases in knowledge, interest, and pro-environmental behaviors when compared to students in a traditional curriculum. However, despite the centrality of place in environmental education, no studies have tested the effect of place itself, potentially because no existing method can separate the effect of place from the other beneficial pedagogical components associated with this practice.

One way to conduct a controlled study is through the use of simulation. In what follows, we use a *place-based simulation* to reproduce authentic problem-based activities about a real place. We evaluate the effect of place by comparing results between overlapping and non-overlapping physical and virtual locations to identify the effects of localizing curricula. Our results show that localized experiences improve student learning, and such a study could only be conducted using a place-based simulation that enables isolation of effects due to localization.

Theory

Place-based education

There are several different versions of place-based education—see, e.g., Gruenewald's (2008) *critical pedagogy of place* and Smith and Sobel's (2010) *place- and community-based education*. However different these approaches are in their specifics, theories of place-based learning generally share two key characteristics: (1) students engage in authentic problem-solving activities; and (2) the problems are situated in the students' own local place—that is, the place where the students themselves live (Gruenewald, 2003; Semken, 2005; Smith & Sobel, 2010; Woodhouse & Knapp, 2000). Semken (2005), for example, describes a place-based curriculum in which students in Arizona use topographic maps to guide the collection of rock, fossil, and soil samples from near their school in order to understand how tectonic forces shaped the geology and resources of their community.

Place-based educators argue that curricula that situate learning in the context of students' own communities help students understand the real-world relevance of their academic work. Unlike more traditional academic approaches which focus on abstract principles, isolated facts, and otherwise decontextualized knowledge, place-based theorists argue that pedagogies that focus on studying issues where students actually live lets them work on concrete, real-world problems in a context they know and care about (Semken et al., 2009).

While in principle place-based education can be developed and applied in any domain, it is most often applied in the context of environmental education. Proponents of place-based environmental education argue that situating learning in students' own local place increases civic and community engagement, interest in environmental issues, and science learning (Powers, 2004; Sobel, 2004). For example, Lieberman and Hoody (1998) conducted a 3-year study of 40 schools across the country, comparing schools using the *Environment as an Integrating Context* curriculum with traditional decontextualized programs. They found that instructional activities based on the local environment around a school increased school achievement across subjects, and increased student engagement and enthusiasm. While these studies did not control for confounding variables, they nevertheless suggest that place-based education can improve teachers' pedagogy and increase student achievement, engagement, and motivation. Based on such studies, Gruenewald (2003) and others (e.g., Smith & Sobel, 2010) claim that place-based learning is the most effective form of environmental education.

Mechanisms of learning in place-based education

Theorists of place-based learning propose two mechanisms through which place-based learning occurs. One is that place-based curricula offer students multiple options for *authentic experiences* that mirror components of the real-world. Barab and colleagues (2009) suggest that when students work in a setting where they can make consequential decisions, they are more engaged in the learning activities because they believe their actions and decisions matter. Place-based curricula can offer students such experiences a real-world context and a real-world problem to solve, each of which can provide personal and community value. In other words, this argument suggests place-based curricula are effective because they provide consequential and realistic problem-solving activities (Smith and Sobel, 2010). Research in Computer Supported Collaborative Learning more generally has shown authentic experiences (Järvela, Häkkinen, Arvaja, & Leinonen, 2004) and problem-based activities are beneficial for learning (Hmelo-Silver, 2004). Arastoopour and colleagues (2014) have demonstrated that authentic problem-based activities lead to greater gains in confidence and commitment than students engaging in traditional instruction, and that this method was particularly effective for women.

A second key mechanism of place-based learning is that students are familiar with the context in which their actions are taking place. The first step in many place-based theories calls for *localization* of the curriculum, which refocuses learning to be about the particular place attributes of nearby or regional locations (Woodhouse & Knapp, 2000). By choosing places that students know about, localization provides the opportunity for students to connect to past experiences and envision future experiences in the setting (Smith & Sobel, 2010). Therefore, place-based education provides both a particular kind of pedagogy—authentic, problem-based learning experiences—and a particular kind of setting—the students' own local context. In other words, place-based education is a *pedagogy of place* that combines authenticity and localization.

Defining local place

While the concept of localization is a key component of place-based education, theorists have struggled to define what constitutes students' own local place and to demonstrate that working in their own local place contributes significantly to students' learning.

Place-based educators emphasize the importance of a local place and often specify features to incorporate into the curriculum from that local place, but rarely identify what constitutes a local place. For example, Semken (2005) defines places as "spatial localities given meaning by human experiences in them" while Gruenewald (2003) and Casey (1997) argue that a local place is one that people live in and know directly. In each of these definitions, nearness is a core component, yet the bounds of this physical distance are never defined. In their seminal book on place-based education, Smith and Sobel (2010) summarize five of the most popular definitions of place-based education, including their own, and outline seven other antecedents to this pedagogy yet never define or specify what constitutes a local place or community. In response to Gruenewald and others, Stevenson (2008) questions the concepts of local and place, asking what educators and theorists actually mean when they advocate for learning about a local place.

There is a body of research, primarily in sociology and urban planning, on *attachment* to a place: that is, the extent to which people feel that they belong in or to a place, and their perception that the place is familiar and "their own" (Devine-Wright, 2013). More than 75% of place attachment studies focus on the neighborhood scale (Lewicka, 2011), which Devine-Wright (2013) and others (Feitelson, 1991) argue limits understanding of the different scales of place and that place attachments may occur at multiple scales. To address this issue, Laczko (2005) collected data from 24 countries and found that after their high affinity to their country, United States citizens felt closest to their state community rather than their neighborhood or city.

Testing a pedagogy of place

Although place-based education may sound promising and beneficial, a fundamental assumption of this pedagogy has not been tested: the effect of the *place* itself. As described above, extant research comparing place-based education with traditional curricula has not controlled for the simultaneous effects of *authentic experiences* and *localization*, both of which are hypothesized as key components of a pedagogy of place. When compared with traditional classrooms, do students in place-based curricula do better because of localization, or because activities are authentic, or merely that they leave the classroom? Or is there some synergy between these elements of a pedagogy of place that make it more effective than either localization or authentic experiences alone?

In other words, while place-based curricula are localized, they are also authentic, problem-based learning experiences, which have been shown to be effective in their own right. Without controlling for the impact of authenticity it is not clear whether localization improves student outcomes.

One way to disambiguate the impact of localization from the other features of place-based learning would be to compare the effects of local and non-local experiences of the same place-based curriculum. Such a study would require a curriculum that could present students with authentic, problem-based issues situated in an *existing* place, but in one that is not the student's *own* local place. So, for example, students would have to use Semken's (2005) place-based geology curriculum (described above) based on the specific rock formations near the Colorado Plateau even though they did not live in Arizona. However, the curriculum has students use local topographic maps to identify places to collect rock, fossil, and soil samples to learn about local rocks and local ground and surface water resources. To adapt this place-based curriculum to another part of the country would require finding a different local land formation for collecting samples that had similar petrologic and hydrologic properties – or rewriting the curriculum to focus on different geologic issues. In other words, changing the location of the curriculum potentially requires a substantial reworking of the original curriculum.

An alternative way to address this issue would be to simulate the two main components of place-based education: *authentic problem-based learning* and *specific local contexts*.

Simulations are technological environments that are designed to reproduce events, places, experiments, and processes from the real world (Dawley & Dede, 2014). In such environments, designers can replicate problem-solving contexts, real-world activities, professional tools, common social interactions, and realistic work products. For example, Chesler and colleagues (2015) created *Nephrotex* where students can role-play as engineering interns at a biotechnology company designing filtration membranes for kidney dialysis. Simulations such as *Nephrotex* offer students the ability to engage in *authentic problem-based learning* about core disciplinary ideas in realistic settings.

Current study

In this study, we explore the impact of a *place-based simulation* (PBS): a simulation that engages students with authentic problem-based learning *about a real location*. One example of a PBS is the virtual internship, *Land Science*, in which students assume the role of interns at a fictitious urban planning firm. Students engage in realistic professional work in a meaningful real-world context (Chesler et al., 2015) by performing the kinds of tasks that urban planners do in their training: they receive materials that urban planners use, such as research reports, ecological impact surveys, and communications from concerned citizens, which provide information about revenue, water pollution, housing, and other issues. Students engage in these authentic problem-based activities to develop and justify land-use plans that meet the needs of competing stakeholders. Additionally, *Land Science* simulates these activities in the specific context of an urban planner working in Lowell, MA, using content, history, stakeholders, environmental indicators, and maps that are place-specific to that city. Through participation in *Land Science,* students learn about complex eco-social systems (Bagley & Shaffer, 2011) and learn to think like urban planners in the context of a real city (Beckett & Shaffer, 2005). In this sense, Land Science is a curriculum that is *based on a real place* and replicates core elements of place-based pedagogy.

PBSs like Land Science have several advantages. Typically, in order to adapt a place-based curricula to a new location, educators would need to adapt existing materials to ensure that the curriculum is both specific to a place and uses authentic practices. Because PBSs are based on a real place and use authentic activities, students can interact with the same curriculum from anywhere. As a result, the experience could be local for some students and not for others depending on the geographic location of the student. In other words, we can use Land Science to hold authenticity constant and vary the localization of the curriculum. We can, therefore, test differences in student performance between students who might consider Lowell, MA their own *local* place against students in other areas across the country who are engaging in a *non-local* experience.

Of course, in order to test the effect of place, meaningful measures for environmental education must be used to identify differences. Commonly, environmental educators are interested in cognitive, affective, and behavioral changes. For example, the North American Association of Environmental Education (2013) identified the goal of environmental education as creating environmentally literate students, where literacy is contingent upon changing skills, values, and behaviors instead of solely increasing content knowledge. Therefore, we assessed differences between local and non-local experience using common cognitive, affective, and behavioral outcomes. To address cognitive changes, we assessed students' ability to identify an example of a scientific model—a model that resembles, represents, and/or summarizes the functionality of an object or phenomenon by making a particular feature of the world easier to understand, define, quantify, visualize, or simulate (Lehrer & Schauble, 2006)—because modeling is a critical practice of science in general and of environmental science in particular (Bagley & Shaffer, 2011). Because the virtual internship addresses learning about urban planning, we assessed interest in cities and the environment as an affective outcome. Finally, we assessed changes in future behavior by adapting a civic engagement measure about knowledge and ability to engage in community problems (Flanagan, Syvertsen, & Stout, 2007) that was adapted for middle and high school students and included school as a possible community.

In this study, our primary research questions examine the relationship between online place and location of play across three different outcomes. In this study, we ask:

1. Do students who engaged in a local PBS have *higher ability to identify a science model* after the simulation than students who engaged in a non-local PBS?
2. Do students who engaged in a local PBS have *higher changes in interest* than students who engaged in a non-local PBS?
3. Do students who engaged in a local PBS have *higher changes in civic engagement* than students who engaged in a non-local PBS?

Methods

Land Science virtual internship

In the virtual internship *Land Science*, students explore the environmental and socio-economic impacts of land-use decisions. Students role-play as urban planning interns at Regional Design Associates, an urban planning firm developing a land-use plan for the city of Lowell, Massachusetts. Students work individually and in teams to develop a rezoning plan for Lowell that addresses the demands of various community groups who advocate for environmental and socio-economic issues such as wildlife protection, job creation, housing, and controlling air and water pollution. Students use iPlan, a geographic information system model, to evaluate the impacts of land use. Each zoning plan cannot address all of the stakeholder's concerns, so students must make and justify decisions about which demands to meet and how to meet them. The virtual internship takes ten to fifteen hours to complete.

Local and non-local simulations

Following Laczko (2005) as discussed above, we categorized students who engaged in the *Land Science* PBS about the state they live in and know about as students who had a *local* experience of a place-based curriculum. We categorized students who engaged in the *Land Science* PBS about a state where they do not live as students who had a *non-local* experience of a place-based curriculum. Because simulations can be played from many sites about endless simulated locations, the *Land Science* PBS provided a platform to test the differences between local and non-local experiences of a place-based curriculum.

Participants

We collected pre- and posttest responses from 94 middle and high school students who participated in one of 10 different implementations of *Land Science* (6 local and 4 non-local). All students participated in *Land Science* as part of an informal science learning experience run by a teacher in a place-based science education center. We examined data from 68 students who engaged in a local PBS and 26 students who engaged in a non-local PBS. To be included in analyses, students must have completed the internship and answered all three sets of questions.

Measures

Students completed an online survey before (pretest) and after (posttest) participating in *Land Science*. The survey had three components: (1) *Scientific Modeling*, (2) *Interest*, and (3) *Civic Engagement*.

Cognitive measure: Scientific modeling score

The survey asked students to write an example of a scientific model. Answers were scored with 1 point if they provided an accurate example of a scientific model and 0 points otherwise. For example, some students incorrectly identified elements of the scientific method, such as "in a scientific model, you need to do basic research and to have a hypothesis." While correct responses would include accurate examples of a model such as a "globe" or "double helix" model of DNA. Two raters achieved acceptable interrater reliability on a subset of the data (n = 126, Cohen's κ = 0.91, Shaffer's $\rho(0.65) < 0.01$), and a single rater coded the rest of the data (please see Shaffer (2017) for more details).

Affective measure: Interest score

The survey asked students to respond to an open-ended question about their interest in cities and the environment. Table 1 lists the five codes that identify varying types of interest. Two raters coded a subset of 120 responses. We compared their rate of agreement and all five scores had acceptable agreements (Cohen's κ < 0.65, $\rho(0.65) < 0.01$) resulting in a weighted Kappa of 0.72. A single rater scored the rest of the data.

Table 1: Categories to code student interest in the cities and/or the environment

Category	Points	Example
No Interest	0	"I have no interest in cities or the environment"
Interest in *either* a specific city or cities *or* the a specific environmental issue	25	"I'm interested to learn about how cities work"
Interest in *both* a specific city or cities *and* the a specific environmental issue or issues	50	"I want to learn about plans that help out cities and the environment."
Interest in the *relationship* between cities and environment generally	75	"I'm interested in learning how we affect the environment and what we can do to reduce to effect our cities have on the environment."
Interest in a *specific relationship or relationships* between cities and the environment	100	"I'm interested in making room for the entire population of the city, without overcrowding, while keeping the environment intact."

Behavioral measure: Civic engagement score

The survey asked students to self-report their knowledge and ability to engage in school and community problems by answering 11 four-point Likert Scale questions adapted from Flanagan, Syversten, and Stout (2007), questions such as: "I know ways of addressing community problems" and "I would be able to find and examine research related to the issue." We summed the student scores for each of the 11 questions and rescaled the result to create a *Civic Engagement Score* from 0 to 100 for each student at two time points (pretest and posttest), where a score of zero indicated strong *disagreement* on all questions and 100 indicated strong *agreement* on all questions.

Analyses

We constructed a series of nested multiple regression analyses to predict the change in outcome for students' *Interest* and *Civic Engagement Scores*. Because *Scientific Modeling* was a dichotomous variable we constructed a series of nested logistic regressions to predict this outcome. In each analysis, we tested the following predictors: location, pretest Civic Engagement Score, pretest Interest Score, and pretest Scientific Modeling Score. Pretest measures were included in each set to control for differences in students' academic ability levels across the 10 implementations included in the study. We computed the Bayesian Information Criterion (BIC) to determine which of the models had the best balance between model fit and model simplicity. For each set of models, we chose the model with the lowest BIC and reported the associated tests for that model.

Results

Change in scientific modeling score

The optimal nested logistic regression for Scientific Modeling included location and scientific modeling pretest as predictors which had a significant regression equation, $X^2(2) = 21.25$, $p < 0.001$ (see Table 2). Students who were able to identify a scientific modeling example at the beginning of the game had a 3.09 times higher relative chance of identifying a model after the internship than students who were unable to identify models at the beginning of the internship. For students in Massachusetts, the relative chance of identifying a model is approximately 2.34 times higher than students who played *Land Science* in a different state. There was no effect of civic engagement pretest and interest pretest.

Table 2: Logistic regression results predicting change in Scientific Modeling Score

		Predictors				Model Comparison	
Model	Intercept	Modeling	Location:	Civic Egmt	Interest	Pseudo	BIC

		Pretest	MA	Pretest	Pretest	R^2	
Null	0.22					--	295.35
	(0.14) *1.25*						
I	-0.24	1.07***				0.05	286.72
	(0.19) *0.79*	(0.29) *2.90*					
IIA	-0.01		0.75*			0.02	294.55
	(0.17) *0.99*		(0.31) *2.12*				
IIB	-0.36			0.01		0.00	299.72
	(0.60) *0.70*			(0.01)*1.01*			
IIC	0.29				-0.00	0.00	300.63
	(0.29) *1.33*				(0.00) *1.00*		
III	-0.53*	1.13***	0.85**			0.07	284.80
	(0.22) *0.59*	(0.30) *3.09*	(0.32) *2.34*				
IV	-1.71*	1.21***	0.90**	0.02	0.00	0.08	292.55
	(0.76) *0.18*	(0.31) *3.34*	(0.33) *2.46*	(0.01)*1.02*	(0.01) *1.00*		

Standard errors are reported in parentheses. Odds ratios are reported in italics. *$p < 0.05$, ** $p < 0.01$, and ***$p < 0.001$. $n = 94$.

Change in interest score

The optimal nested regression model for Interest Score based on BIC included location and interest as predictors which had a significant regression equation ($F(2,91) = 13.26$, $p < 0.001$), with an adjusted R^2 of 0.21 (see Table 3). Participant change in interest scores decreased by 0.51 percent for each 1-point increase in the pretest score indicating that students with lower interest at the start of the game had higher increases in interest. On average, students in Massachusetts increased their interest score by 21.41 percentage points more than the scores for students in a different state increased. Because we scaled these tests to have a maximum value of 100, this difference in scores between local and non-local students, controlling for their pretest score, would be the equivalent of increasing two letter grades. There was no effect of civic engagement pretest or example pretest.

Table 3: Regression results predicting change in Interest Score

		Predictors				Model Comparison	
Model	Intercept	Interest Pretest	Location: MA	Civic Egmt Pretest	Modeling Pretest	Adjusted R^2	BIC
I	28.13***	-0.49***				0.12	914.34
	(5.52)	(0.13)					
IIA	-3.85		20.39**			0.08	919.29
	(5.93)		(6.97)				
IIB	19.18			-0.12		-0.01	927.21
	(13.07)			(0.19)			
IIC	9.88*				-0.02	-0.01	927.56
	(4.82)				(0.07)		
III	13.21	-0.51***	21.41**			0.21	908.15
	(6.91)	(0.13)	(6.46)				
IV	6.79	-0.53***	22.58**	0.12	0.03	0.20	916.66
	(13.73)	(0.13)	(6.70)	(0.18)	(0.06)		

Standard errors are reported in parentheses. *$p < 0.05$, ** $p < 0.01$, and ***$p < 0.001$. $n = 94$.

Change in civic engagement score

The optimal nested regression model for Civic Engagement Score based on BIC included location and civic engagement pretest score as predictors which had a significant regression equation ($F(2,91) = 15.83$, $p < 0.001$), with an adjusted R^2 of 0.24 (see Table 4). Participant civic engagement scores decreased by 0.34 percent for each 1-point increase in the pretest score indicating that students with lower pretest scores showed greater change in civic engagement score. On average, students in Massachusetts had a change in civic engagement score that was 9.74 percent higher than the change in score for students playing *Land Science* in a different state. Because we scaled these tests to have a maximum value of 100, the difference in post-test scores between local and non-local students, controlling for their pretest score, is the equivalent change of one full letter grade. There was no effect of example pretest or interest pretest.

Table 4: Regression results predicting change in Civic Engagement Score

		Predictors				Model Comparison	
Model	Intercept	Civic Egmt Pretest	Location: MA	Modeling Pretest	Interest Pretest	Adjusted R^2	BIC
I	32.86***	-0.39***				0.17	776.96

	(5.88)	(0.09)					
IIA	-1.63		12.10***			0.11	783.61
	(2.88)		(3.39)				
IIB	10.22***			0.06		0.02	792.62
	(2.35)			(0.03)			
IIC	7.04*				0.00	-0.01	795.82
	(2.94)				(0.07)		
III	22.74***	-0.34***	9.74**			0.24	772.30
	(6.53)	(0.08)	(3.18)				
IV	17.92*	-0.32***	10.36**	4.89	0.03	0.25	777.93
	(7.00)	(0.09)	(3.20)	(2.87)	(0.06)		

Standard errors are reported in parentheses. *$p < 0.05$, ** $p < 0.01$, and ***$p < 0.001$. $n = 94$.

Discussion

Our results suggest that curricula situated in a specific, real place are more effective when that place is local to the learners. To predict change in each outcome, we included the location, relevant pretest, as well as the other pretests to see which variables might explain differences in the score. For each of the three outcome variables, however, the nested regressions showed that only the relevant pretest and location were significant predictors of the change in outcome. Models that included both the relevant pretest and location best explained the change in outcome and that this model was more parsimonious than models that included all four predictors. These results suggest that even though all students engaged in the same authentic activities and problem-based learning about a real place, we found that students showed different changes in outcomes based on their location. When students engaged in a simulated place-based curriculum about their state, they had higher changes in civic engagement, interest, and ability to identify a scientific model than students in other states.

These results have implications both for the study of place-based pedagogies and for the use of simulations in education more generally.

While the importance of local place has been assumed in place-based education research, this is the first work we are aware of that provides empirical evidence to support this claim. It may be that previous studies have made this assumption because of the physical constraints that limit the places students can experience in an engaging and immersive way. Our results suggest that when students experience a simulation of authentic and problem-based learning about a specific place, it makes a difference if it is their own local place. Thus, as Gruenewald (2003) and other place-based theorists argue, environmental education may be more effective when it engages students in the places where they live.

More broadly, though, researchers who study educational simulations argue that one benefit of these tools is that educators can create curricula that can be accessed from locations anywhere in the country or world (Dawley & Dede, 2014). This means that students are not limited in their access to sound pedagogies based on the resources of their own communities. However, this study suggests that local context has a powerful influence on how students perceive and experience an online curriculum. There are surely important ideas that are best understood through the lens of distant or imagined worlds, but it may be that students are more swayed by Thoreau's (1981) argument that "it is not worth the while to go round the world to count the cats in Zanzibar." As a result, teachers may need the ability to customize one-size-fits-all simulations—or perhaps more accurately, one place fits all simulations—to use them more effectively in environmental science classrooms.

This study has several limitations. First, it describes a small number of students in a small number of locations where students could not be randomly assigned to a locality. However, this reestablishes the problems in measuring the effect of place. While we were not able to use randomization and the sample size was not large enough to account for differences in the implementations such as length or background work by teachers, we would be quick to point out that we have no reason to believe that those are systematically related to the place in which they were implemented. As a result, although we are currently working to expand this analysis to a larger sample size with more locations, the implications of this study should be generalized with caution. Second, this study tested only one definition of local place and does not explore all of the complex issues involved with conceptions of space or place. Future analyses could examine the impact of different spatial scales for locality to better understand the relationship between localization and learning. Finally, this study focused on three limited outcomes measured in a pretest-postest design. As a result, it provides no information on the mechanisms by which locality impacted learning in this environmental education simulation, and future studies are needed to better understand the effect of locality on science content and practice learning within place-based simulations.

Despite these limitations, these results suggest that students have higher changes in civic engagement, interest, and ability to identify a scientific model when they engage in a place-based simulation about their own local place—and that advocates for place-based education are correct in arguing that situating curriculum in students local place has a positive impact on student outcomes. Place does matter.

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