Intellectus

Volume 1
Issue 1 *Inaugural Issue, August 2023*

Article 3

August 2023

Preparing for Pandemics: Lesson Plan Design for Children in Elementary School

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Recommended Citation

Rivera D, Sainbayar E, Choudry S, Vaughn Pierce B, Nouri-Nikbakht R, Lewis JH. Preparing for Pandemics: Lesson Plan Design for Children in Elementary School. *Intellectus*. 2023; 1(1). DOI: https://doi.org/10.61442/2994-4384.1003

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Preparing for Pandemics: Lesson Plan Design for Children in Elementary School

Cover Page Footnote

The authors thank Principal Colin Kelly, MEd, and Tracy Sanders, BS, the librarian at the participating Arizona elementary school for allowing the study researchers to interact with the students. The authors thank the fellow students and staff for assisting with the project: Benjamin Finch, BS, OMS IV; Erin Herbert, BS, OMS IV; Addison Hill, BS, OMS IV; Sean Hollebeck, ScM, OMS III; Issa Ismail, BS, OMS IV; Zac Sanders, BS, OMS IV; Mark Sivakoff, MD; Bradley Meek, DO; Kate Whelihan, MPH, CPH.

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This original article is available in Intellectus: https://scholarworks.atsu.edu/intellectus/vol1/iss1/3

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ABSTRACT

Context:
The COVID-19 pandemic necessitated distance learning to attenuate the spread of the virus, and school-aged children were particularly affected by this change. Because of their age and education level, children generally lacked understanding about the pandemic and the preventive measures necessary to prevent the spread of this and other infectious diseases. It is unknown how many schools nationwide incorporated disease-prevention education in their curriculums during the pandemic. Therefore, developing distance learning interventions that convey these topics at their level of understanding is important to improve health literacy and raise their awareness of factors that positively influence health.

Objective:
To implement a distance learning intervention that teaches elementary-aged children about infectious diseases and pandemics and to evaluate their understanding of the material.

Methods:
A four-week program with weekly lessons was developed to teach fifth grade students about infectious diseases and pandemics. Weekly lessons involved one or two instructional videos, preintervention and postintervention quiz, live online interactive session. Participants also completed a survey before (Presurvey) and after (Postsurvey) the entire 4-week program to evaluate their understanding of the material.

Results:
61 fifth graders (ages 10-11) participated in the project. Quiz scores improved from preintervention to postintervention for week 1 (74% [3.0] vs 86% [2.2], $P<.001$), week 2 (85% vs 88%, $P=.34$), and week 3 (78% vs 83%, $P=.20$). Scores were the same in week 4 (95%, $P=.86$). Survey responses before and after the program also improved, particularly for questions related to understanding what it means to be in a pandemic (33% [18/54] vs 55% [24/44], $P=.008$) and that SARS-CoV-2 is a virus and causes COVID-19 (4% [2/54] vs 27% [12/44], $P<.001$). For the extra survey item, 52% (23/44) felt they had learned something about the topics after the lessons.

Conclusion:
Project results suggested that our distance learning intervention improved fifth grade students' knowledge about infectious diseases and pandemics. Although it was difficult to maintain the same response rate for weekly quizzes or to fully engage participants during the virtual lessons, the live interactive sessions were well received and seemed to improve their understanding of these topics. Because our project intervention seemed to provide participants with greater health literacy, similar interventions should be considered for other grade levels at elementary schools across the country to promote awareness about infectious diseases or other global health issues.

INTRODUCTION

In 2020, the COVID-19 pandemic caused multiple challenges for all levels of education. School-aged children were affected by the rapid change to distance learning to control the spread of the virus. According to the United States Census Bureau, 93% of households transitioned to various types of distance learning during the COVID-19 pandemic. Once the pandemic was somewhat abated, education returned to in-person learning.[1] Although children can copy parent behaviors, school-aged children generally lacked the understanding of preventative measures to diminish the spread of COVID-19 and other infectious diseases.[2]

In a 2020 study on pediatric cases of COVID-19, the authors had a cohort of 192 children and 49 (26%) were diagnosed with acute SARS-CoV-2 infection, and only 25 of those diagnosed 49 children (51%) presented with fever, other nonspecific symptoms, or no symptoms. Although children tended to have milder disease than adults and many had asymptomatic COVID-19 infections, they were still significantly impacted. Further, healthy children could potentially pass the virus on to more vulnerable people.[4-7] Thus, educating children about COVID-19 and other infectious diseases is important, so they understand the consequences of such diseases, whether they experience symptomatic disease or not.

There have been studies that investigated educating children about infectious diseases.[8,9] Because of the severe acute respiratory syndrome outbreak of 2003, Koller et al. investigated children's (N=21) knowledge of pandemics and found that they understood the need for planning to minimize the challenges of future pandemics.[8] Children in that study also recognized the importance of addressing psychosocial needs, infection control, communication, and management of resources.[8] After the 2009 H1N1 influenza virus outbreak, Remmerswaal and Huris studied the fear reactions of 223 children aged 7-12 years.[9] They found that children had higher fear levels the more their parents warned them about the dangers of the disease ($P<.001$).[9] Additionally, when parents conveyed the threat information, there was an increase in children's fear scores, even after controlling for other sources of information about the H1N1 virus ($P<.001$).[9] Results of these studies highlight the need for proper education of children about infectious diseases and pandemics to mitigate misinformation and to provide information without unnecessarily increasing fear.[8,9]

For school-aged children, interactive and experiential learning have been shown to facilitate knowledge acquisition.[10-12] For instance, conversations verbalizing the information being taught or having children teach learned information to friends and family can reinforce retention.[10] Similarly, performing activities that reinforce learning, such as hand washing or social distancing when teaching health education, can increase understanding of the material.[11] This kind of experiential learning is supported by a systematic review that found children may benefit most from hands-on experiences.[12] In distance learning environments, like that caused by the COVID-19 pandemic, interactive and collaborative teaching methods are critical for effective learning. In a study by Hyman et al, children who were comfortable and confident with distance learning benefited from digital health education and were more likely to make healthier life choices.[13] Therefore, combining hands-on and distance learning may be an effective method for improving health literacy to children.

In general, health literacy is a modifiable factor that can improve understanding of strategies to mitigate the spread of communicable diseases.[14] Throughout the COVID-19 pandemic, the spread of false information highlighted the importance of proper health education[10] and the need for basic health literacy[15] to prevent psychosocial consequences[7] of misinformation.[7,10,15] Because of the misinformation, many people were confused about what a virus is, how it spreads, and how prevention and intervention work.[7] This confusion and misinformation were particularly stressful for children, and as a result, they may experience long-

lasting negative effects on their overall health.[7] Because health literacy is so vital, Aghazadeh et al evaluated 365 second graders before and after health literacy lessons.[16] Using a pretest–posttest project design, the authors found that the mean (SD) health literacy score increased from preintervention quizzes (2.23 [1.47]) to postintervention quizzes (3.34 [1.35], $P<.001$), which indicated proficient health literacy.[16] These results suggest that children can learn the knowledge and skills necessary to navigate situations involving infectious diseases, improving their overall health literacy and reducing their susceptibility to health misinformation.

Therefore, implementing distance learning interventions at an elementary-aged education level may limit the spread of current and future infectious diseases and potentially save lives. By teaching children about the COVID-19 pandemic and other infectious diseases, we may be able to mitigate the psychological stress and fear caused by such diseases and improve overall health literacy. The purpose of the current project was to implement a distance learning intervention to teach elementary-aged children about infectious diseases and pandemics and to evaluate their understanding of the material. We hypothesized that our distance learning intervention would improve their understanding of infectious diseases and basic preventative measures. Ideally, our intervention would provide them with the appropriate tools to help prevent the spread of future pandemics.

The project closely follows the osteopathic model of care with regards to the behavioral aspect of health care. This model is an important aspect of healthcare which is often overlooked and demonstrates one of the everlasting impacts of the pandemic that may not be given much attention with societal views on mental health. However, as children may show the psychological and mental effects from the pandemic, it brings to light the importance of addressing the behavioral model of osteopathic medicine.

METHODS

Participants

The current project used a preintervention quiz and postintervention quiz design and convenience sampling to recruit children in fifth grade (aged 10-11 years) from three separate classes at an elementary school in a metropolitan area in the Southwestern United States. Since the mean reading ability of adults in the United States is estimated to be at the eighth-grade level, it is recommended that educational materials be written below a sixth-grade reading level.[16-18] For an appropriate assessment of the intervention, we therefore included fifth graders in our project, with their lower than national average reading level.[19] Although participation in the project was voluntary, we incentivized participation by offering prizes (toys, masks, small items), to individuals and the overall class that participated the most.

No identifying information was collected, but the total number of responses per survey and quiz were monitored to assess participation. Identifying information was unnecessary since the overall score among the entire project cohort was analyzed. The students' participation was monitored by the schoolteachers present on the school's distance-learning platform. Quizzes were collected anonymously by the teachers and assessed for overall participation by the total amount of quizzes received compared to the number of students enrolled in the project. The local institutional review board determined our project to be non-jurisdiction. Before participation, each child provided their assent, and informed consent was obtained from the child's parent or guardian.

The resulting four-week program focused on a specific infectious disease topic each week. In week 1, the intervention focused on viruses and taught the children a basic understanding of viruses. In week 2, the intervention taught the children about the pandemic and how germs spread.

In week 3, the intervention included general strategies to prevent infectious diseases. In week 4, the intervention focused on prevention strategies specific to the COVID-19 pandemic.

The intervention followed the same format each week. On Mondays, the children completed a preintervention quiz about that week's topic to measure their baseline understanding. Next, they watched one or two short instructional YouTube videos about the topic followed by an experiential learning activity or a Kahoot competitive quiz. Week 1 YouTube videos focused on what a virus is and how to teach kids about viruses.[20, 21] Week 2 YouTube video detailed the importance of washing hands.[22] Week 3 YouTube videos concentrated on hand washing, coughing, and sneezing.[23, 24] Week 4 YouTube video centered on social distancing.[25]

On Wednesdays, the children attended a 30-minute virtual meeting to discuss the contents of the videos. During these interactive sessions, the children were encouraged to ask questions and answer the teams' questions about that week's learning topic. They also played games or performed activities that supplemented the information. The materials for the Wednesday interactive learning activities were disseminated to the children before the session by their teachers. On Fridays, the children completed a postintervention quiz that was identical to the preintervention quiz to assess changes in their knowledge. All lesson plans were pre-approved by the teachers of the three classes and the principal of the elementary school.

The week 1 activity materials required a writing instrument and paper. All students were instructed to draw a smiley face on the piece of paper that signified a healthy cell. Then all students showed their respective drawings on their computer cameras. Via a private online chat message, we informed 5-10 random students to draw a face with scary teeth and scary eyes to represent an infected cell. The remaining students were instructed to draw another smiley face, so all students had two drawings. We informed the students that in our hypothetical scenario, a student visited a friend, went to the grocery store, or attended a birthday party where someone was ill. Next, all students showed their drawings on their computer screens. We explained through this activity how some cells become infected with a virus and how easily it can spread.

For the week 2 virtual meeting, we first reviewed the previous week's material and answered any questions the students had. The only material required was standard hand soap. Students were asked to put a pump of soap on their hands and have it sit on their hands while they watched a YouTube video.[26] After the video, we asked the children if any of the soap got on anything they might have touched around them. This demonstration highlighted how easily "germs" can be spread and were asked questions that included: what did the "germs" (soap) get on? Which objects? Your face? Who avoided touching things because they knew they had "germs" (soap) on them? Students were then allowed to wash their hands and were asked to come back to view the final YouTube video for the live session.[27] After the video, the team opened the meeting to any questions that the children had, which were answered accordingly.

The week 3 live activity followed a similar format. After answering questions regarding the previous week's material, we discussed proper handwashing techniques, how to cover a cough/sneeze, and how to correctly wear a mask. A YouTube video was shown that reviewed the contagiousness of a sneeze and how to effectively block it.[28] When reviewing proper handwashing, students required a bowl of water, black pepper, and soap. The students then watched another YouTube video detailing the experiment and added black pepper to the bowl of water, symbolizing germs in the environment.[29] Students placed their non-washed finger into the bowl and observed how the pepper remained in place in the water. Then, students put soap on their index finger and put their finger in the water bowl, which repelled the pepper. This experiment highlighted the importance of handwashing to repel germs. The second activity for week 3 required a paper pinwheel provided by the investigators. Children blew on the pinwheel with and without their

masks on to show the importance of wearing a mask in prevention of spreading respiratory droplets.

Week 4 followed a similar format. First, any questions about the material from previous weeks were answered and students were instructed to share their activities during quarantine to stay busy and connected with peers. The students were asked to give examples of a 6-foot distance based on their own experiences and from what they learned in the video[25] they watched a few days prior. An online Kahoot trivia game created by the investigators was played with the students to test their knowledge on social distancing and review lessons from previous weeks. Finally, we answered any remaining questions.

All quiz questions were written at an appropriate reading level for our participants (Table 1). The week 1 quiz included 4 items, and each of the remaining quizzes had 3 items. Participants also completed a survey before (Presurvey) and after (Postsurvey) the program to evaluate their understanding of the material. The surveys were developed specifically for the current project and included 5 Likert-scale items with values ranging 1 - 5, with 1 being "strongly disagree" and 5 being "strongly agree" (Table 2). An extra Likert-scale item was included in the Postsurvey. Both the Presurvey and Postsurvey also included free-text items that were included so the participants could use their own words to explain their comprehension of pandemics and preventative measures. The Postsurvey had 3 free-text items: (1) tell me what you know about pandemics, (2) I can help stay safe and stop the spread of COVID-19 by—, and (3) after everything you have learned, will you plan to do anything differently to help stop the spread of any disease (not just COVID-19)? The Presurvey included only the first 2 items. Quizzes and surveys were completed electronically using the school's online portal. It is estimated that each of the quizzes and surveys took approximately 5-10 minutes to complete.

Table 1. Weekly Preintervention and Postintervention Quiz Questions Used in the Current Project

Quiz Item	Type of Response
Week 1	
1. What is a virus?	Multiple choice
2. How does a virus make us sick?	Multiple choice
3. About how long does it usually take us to get better after we get sick with a virus in general?	Multiple choice
4. Older people or people who are already sick with other illnesses (like asthma) might have a harder time fighting viruses.	Binary True or False
Week 2	
1. What is a pandemic?	Multiple Choice
2. How do germs spread?	Multiple Choice
3. Virulence refers to how harmful a microbe may be. Some can be very harmful and make us very sick, while others do not.	Binary True or False
Week 3	
1. How long should you scrub when washing your hands?	Multiple Choice

2. Why should we sneeze into our elbows?	Multiple Choice
3. Who is wearing their mask correctly? (Image shown)	Multiple Choice
Week 4	
1. At least how much distance should you keep when physically distancing from another person?	Multiple Choice
2. Why is it important to quarantine if you believe you could have caught COVID-19?	Multiple Choice
3. What are some ways you can help stop the spread of COVID-19? Click all that are correct.	Select Multiple Answers

Table 2. Presurvey and Postsurvey Questions Used in the Current Project before and after the entire 4-week program, respectively.

Survey Item	Response Type
1. I understand what an infectious disease is.	Likert scale
2. I understand what it means for the world to be in a pandemic.	Likert scale
3. I understand what the SARS-CoV-2 virus is and how it causes COVID-19.	Likert scale
4. I understand how to prevent the spread of viruses.	Likert scale
5. I understand why washing my hands is important.	Likert scale
6. I feel like I learned something about the topics presented after these lessons.[a]	Likert scale
7. Tell me what you know about pandemics (what they are, how they spread, how to stop them).	Free text
8. I can help stay safe and stop the spread of COVID-19 by:	Free text
9. After everything you have learned, will you plan to do anything differently to help stop the spread of any disease (not just COVID-19)?[a]	Free text

[a]This question was only included in the postintervention survey.

Statistical Analysis

Project data was downloaded from the elementary school's online portal. Quiz scores were calculated as the number of correct responses and reported as a percentage. A mean (SD) score was calculated for each week and for each quiz item for that week. Survey responses were ranked ordinally on a scale of 1-5 points with 1 being strongly disagree and 5 being strongly agree. Ranked scores were summarized using frequency and percentage, and aggregate scores were calculated for preintervention and postintervention surveys. Aggregate scores were utilized as it is a common way to provide statistical analysis for a group of people and produce a summary data. Wilcoxon rank sum tests were used to test for differences between Likert-scale questions for the Presurvey and Postsurvey. Fisher exact tests were used to assess percent change in score for each quiz item. For participant responses to the survey's free-text items, responses were grouped by common domains using recurring keywords. They were grouped to qualitatively assess the responses. Microsoft Excel was used for analyses, and a $P<.05$ was considered statistically significant.

RESULTS

Sixty-one fifth graders participated in the project. Because participation was voluntary, the number of participants in each session varied.

Quiz scores improved from preintervention to postintervention for week 1 (74% vs 86%, $P<.001$), week 2 (85% vs 88%, $P=.34$), and week 3 (78% vs 83%, $P=.20$). Scores were the same in week 4 (95%, $P=.86$) (Table 3). Only week 1 had a significant difference between preintervention and postintervention scores. During that week, a significant percent change of 24% ($P=.02$) was found between scores for item 2.

Table 3. Preintervention and Postintervention Quiz Scores of Project Participants (N=61)

Quiz Item	Preintervention	Postintervention	*P* Value
	No. Correct (%)	No. Correct (%)	
Week 1 (n=56)	(74)	(86)	<.001
Question 1	54 (96)	40 (100)	.51
Question 2	26 (46)	28 (70)	.02
Question 3	30 (54)	29 (73)	.08

Question 4	55 (98)	40 (100)	>.99
Week 2 (n=54)	(85)	(88)	.34
Question 1	54 (100)	48 (98)	.48
Question 2	39 (72)	39 (80)	.49
Question 3	44 (81)	43 (88)	.43
Week 3 (n=46)	(78)	(83)	.20
Question 1	42 (91)	38 (97)	.37
Question 2	19 (41)	16 (41)	>.99
Question 3	46 (100)	39 (100)	NA
Week 4 (n=43)	N = 43 (95)	N = 39 (95)	.86

Quiz Item	**Preintervention**	**Postintervention**	***P* Value**
	No. Correct (%)	**No. Correct (%)**	
Question 1	43 (100)	39 (100)	NA
Question 2	37 (86)	35 (90)	.74
Question 3	42 (98)	37 (95)	.60

Results for survey responses are presented in Table 4. Between the preintervention survey (N=56) and postintervention survey (N=44), aggregate scores increased; more participants agreed

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DOI: 10.61442/2994-4384.1003

or strongly agreed with survey items than disagreed or strongly disagreed. Significant differences were found for questions related to understanding what it means to be in a pandemic (33% [18/54] vs 55% [24/44], *P*=.008) and that SARS-CoV-2 is a virus and causes COVID-19 (4% [2/54] vs 27% [12/44], *P*<.001). Table 4 outlines these results.

Table 4. Presurvey (n=54) and Postsurvey (n=44) Scores of Project Participants for Likert-Scale Questions

Survey Item	Likert Responses, No. (%)				
	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
Question 1					
Presurvey	18 (33)	20 (37)	10 (19)	4 (7)	2 (4)
Postsurvey	24 (55)	19 (43)	1 (2)	0 (0)	0 (0)
Question 2					
Presurvey	18 (33)	26 (48)	7 (13)	3 (6)	0 (0)
Postsurvey	16 (36)	21 (48)	6 (14)	1 (2)	0 (0)
Question 3					
Presurvey	2 (4)	17 (31)	11 (20)	16 (30)	8 (15)

Survey Item	Likert Responses, No. (%)				
	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
Postsurvey	12 (27)	16 (36)	12 (27)	3 (7)	1 (2)
Question 4					
Presurvey	38 (70)	14 (26)	1 (2)	1 (2)	0 (0)
Postsurvey	37 (84)	6 (14)	1 (2)	0 (0)	0 (0)
Question 5					
Presurvey	47 (87)	7 (13)	0 (0)	0 (0)	0 (0)
Postsurvey	39 (89)	3 (7)	2 (5)	0 (0)	0 (0)
Question 6[a]	14 (32)	23 (52)	5 (11)	1 (2)	1 (2)

[a]This question was only included in the postintervention survey.

Common response themes for the free-text survey items are reported in Table 5. For the item about pandemics, participants indicated that pandemics are diseases that "spread around the world, deadly or make people sick, and infectious/contagious." For the item about how they could stay safe and stop the spread of COVID-19, participants identified staying home, covering their coughs and sneezes, and washing hands. For the last item about how they planned to use their new knowledge to stop the spread of any disease, participants reiterated their suggestions on the free-text section of the Postsurvey.

Table 5. Common Themes From the Free-Text Survey Items From the Presurvey(n=54) and Postsurvey (n=44)

Free-Text Survey Item	Common Themes
Question 7	Infectious/Diseases that spread Deadly Places shut down/close Worldwide Preventable
Question 8	Staying at home Social distancing Wearing masks Washing hands
Question 9	Using learned knowledge to prevent the spread Help myself/others stay safe

[a]This question was only included in the postintervention survey.

DISCUSSION

In the current program, we implemented a distance learning education-based intervention to teach elementary-aged children about infectious diseases and pandemics and to evaluate their understanding of the material. Results suggested that our four-week program improved fifth grade students' knowledge about infectious diseases and pandemics. Quiz scores improved from preintervention to postintervention for the first 3 weeks and were statistically significant for week 1. We also found similar increases in aggregate scores between the preintervention and postintervention surveys. The COVID-19 pandemic highlighted the importance of health literacy and overall understanding of preventative measures that can reduce negative outcomes.[30]

Therefore, as elementary-aged children returned to in-person classes, it was essential that they understood infectious diseases and how to diminish their spread. Our educational intervention significantly improved our participants' level of understanding about these diseases and how they spread. This finding was supported by responses to our free-text survey item about future actions to slow the spread of disease: most participants indicated they planned to follow the preventative measures learned during the program. Given our positive results, our 4-week distance learning intervention may serve as a model for preventative medical outreach for children.

Improving the overall health literacy of children and adults is vital for preventing infectious disease, particularly in underserved populations. By teaching children about infectious diseases and pandemics at their level of understanding, we can provide them with the knowledge and empowerment to take charge of their personal health.[31] Such empowerment may also mitigate the psychological stress caused by fear of the unknown and poor health.[8,9] This increased awareness may also lead to better disease prevention and improvements in healthcare outcomes. Given the

negative effects of the "infodemic" regarding COVID-19, healthcare professionals, educators, and government officials should develop programs tailored specifically for children and adults to minimize misinformation in the future and reduce polarization of health-related issues.[31,32]

The current project had several limitations. Our participants were fifth graders from a single elementary school, so our results may not be generalizable to fifth graders at other schools or to elementary-aged children in general. To assess our distance learning intervention more fully, future studies should include a larger number of schools and recruit children from a variety of grades and socioeconomic and educational backgrounds. Future studies should also consider measurement of the change in spread of disease after the intervention. Another limitation of the current project may be related to a lack of long-term follow-up of participants. We intentionally did not include a longitudinal aspect in our project design, and it is unknown whether our results would continue to show positive changes in understanding of the material over time. Even though we included prize incentives to increase participation, the number of project participants varied during the program, which may have impacted our results. Despite these limitations, overall results suggested the intervention provided the children with greater understanding and an improved ability to slow the spread of infectious diseases. Future studies should investigate whether this type of distance learning program can be used to teach elementary-aged children about similar health literacy topics.

CONCLUSION

The COVID-19 pandemic created unique educational challenges because of the rapid transition to distance learning to diminish the spread of disease. Elementary-aged children were particularly affected by this change, and as they returned to in-person education, it was essential to teach them about infectious diseases and preventative measures to keep them healthy. Results of our distance learning intervention suggested that the 4-week program improved fifth graders understanding about infectious diseases and pandemics. Overall, quiz and survey scores improved from preintervention to postintervention. The live interactive sessions were well received and seemed to improve their understanding of these topics. Because age-appropriate health education is necessary to improve health literacy, programs such as ours should be considered across all education levels to promote awareness about pandemics and other global healthcare issues and to instill greater confidence and abilities for navigating similar infectious disease scenarios in the future.

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