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RESEARCH ARTICLE

Learning impacts of policy games: investigating role-play simulations (RPS) for stakeholder engagement in payment for hydrological services program in Veracruz, Mexico

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Abstract

Role-play simulations are often used in education, communication, and social science research as an instrument for experiential learning, skill development, and more recently for policy negotiation and problem-solving. RPS is a dynamic experiential activity in which multiple parties play specific roles to simulate real-life negotiations or problem-solving situations. RPS aims to create a safe forum where participants can discuss policy scenarios, make decisions, and strengthen two-way communication and collective problem-solving. This research contributes to recent research investigating the contribution of RPS as an educational tool to foster collaborative learning, empathy, and trust. We conducted two RPS workshops related to a payment for hydrological services program in the state of Veracruz, Mexico. We engaged stakeholders to discuss PHS program design alternatives and make decisions on the features that may be best for achieving PHS social and environmental goals. We use a mixed-methods approach, analyzing data from surveys, debriefings, and interviews. Our findings support using RPS as a tool to foster collaborative learning. The *t* test analysis shows statistically significant changes in participants' viewpoints about their overall knowledge of PHS programs and improved understanding and empathy toward other stakeholders' interests and concerns. Findings also support a positive shift in how participants perceived the role of PHS program administrators. We discuss the broader implications of these results and provide recommendations for future research on integrating a science-policy interface in the context of PHS programs.

Keywords Ecosystem services (ES) · Collaborative learning · Role-play simulation (RPS) · Learning impacts · Natural resource decision-making · Payment for ecosystem services (PES)

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1 Role-play simulations as experiential methods

Research in education, communication and social sciences uses experiential methods for improving training, skill development, and learning (Chew et al. 2013; McFadgen and Huitema 2017). Experiential methods can contribute to knowledge acquisition, increased awareness, and enhanced trust (Bela et al. 2016), especially when hands-on activities are mixed with traditional teaching methods (Barreteau et al. 2003; Bellotti et al. 2010). Scholars in experiential learning often use different simulation gaming approaches that combine in-person role-playing and computer simulations with diverse types of stakeholders to foster learning (Wang and Davies 2015). The increasing diversity of policy-related games and game settings highlights the academic interest in developing new tools to improve learning outcomes in diverse contexts (Gerlak et al. 2018; Gosen and Washbush 2004). Role-play simulations (RPS) are a type of policy game where learners play specific roles, typically different from their real-world roles, and assume positions to replicate real-life decision-making processes (Rumore et al. 2016; Susskind and Rumore 2013). RPS interactions are structured by a hypothetical environment that encourages participants to make individual and/or group decisions according to diverse scenarios, specific social and environmental variables, and pre-determined outcomes (Druckman and Ebner 2008; Haug et al. 2011).

Several researchers have used RPS to foster dialog between diverse stakeholders in policy debates and to find potential solutions to social-ecological conflicts (Perrotton et al. 2017; Song et al. 2021; Villamor et al. 2014). As a participatory approach to science and decision-making, RPS has received more attention in the last two decades (Andreotti et al. 2020; Cheng et al. 2015; Lalicic and Weber-Sabil 2019; Savic et al. 2016). However, the impacts of RPS on stakeholder engagement are still an understudied area. Researchers and practitioners in stakeholder engagement have called for greater attention to the ways participatory research methods, such as RPS, contribute to the engagement process and produce (either positive or negative) impacts on real-world social-ecological situations (Gerlak et al. 2019; Koontz and Thomas 2006; Newig et al. 2018).

Drawing on research that considers the contribution of RPS to learning and policy debates, we designed and conducted two RPS workshops involving a hypothetical payment for hydrological services (PHS) program in the state of Veracruz, Mexico. PHS[1] is a prominent market-based strategy to incentivize conservation of forests and environmentally friendly agricultural practices that help regulate water quantity and quality (Engel et al. 2008; Muradian et al. 2010; Wunder 2015; Wunder et al. 2018). PHS is based on a voluntary transaction between ecosystem service 'producers' (e.g., landowners) and 'consumers' (e.g., households, industries, water utilities) where payments are made to the former to guarantee service provision to the latter (e.g., water production) (Muradian et al. 2010; Wunder 2015). PHS programs have been applied worldwide, especially in developing countries, to counteract human activities that lead to deforestation and forest degradation (Grima et al. 2016; Hayes et al. 2019; Muñoz-Piña et al. 2008; Rodriguez and Ávila-Foucat 2013). The use of RPS in PHS policy debates is innovative, and it responds to the growing interest in promoting the engagement of stakeholders in environmental decision-making and policy evaluation (Hayes et al. 2019; Izquierdo-Tort et al. 2021; Pfaff et al. 2019).

We engaged participation of diverse local PHS stakeholders to assess the effects of the RPS workshop on participants' perceptions about PHS programs. Our goals were to create a forum to bring together diverse PHS program stakeholders, foster a discussion among stakeholders about possible PHS policy innovations and scientific information, and assess the impact of RPS on participants' learning about PHS programs. In this paper, we test the hypothesis that RPS contributes to participants' learning by (1) improving understanding of complex concepts and scientific information, (2) changing viewpoints on program design options, and (3) fostering mutual understanding and enhanced trust (Baird et al. 2014; Haug et al. 2011; Lumosi et al. 2019). We explore the impacts of a RPS workshop on learning by analyzing both quantitative and qualitative data collected from pre- and post-RPS workshop surveys, post-workshop debriefings, and post-RPS workshop interviews. We begin by examining the literature that analyzes the impacts of experiential methods on learning. Next, we describe our case study and the methods used for collecting quantitative and qualitative data. We then present our findings and discuss how the RPS contributed to participants' learning. We conclude by discussing the value of RPSs and collaborative learning methods for decision-making and policy development.

2 Role-play simulations and collaborative learning

RPS has generated growing interest among social science researchers and public policy practitioners due to its potential benefits for learning and public engagement in decision-making (Crampton and Manwaring 2014; Susskind and Rumore 2013). RPS creates a face-to-face (in person or virtual) decision-making and negotiation scenario in which

[1] See Urcuqui-Bustamante (2021) for a brief explanation of the concepts of payment for ecosystem services (PES) and payment for hydrological services (PHS) https://encyclopedia.pub/entry/history/show/38507.

multiple parties take specific roles and attempt to solve well-defined problems collaboratively (Crampton and Manwaring 2014; Druckman and Ebner 2008; Stokes and Selin 2016). The literature on the use of RPS in education and empirical studies is broad (Cheng et al. 2015; Merlet et al. 2018; Moreau et al. 2019; Stokes and Selin 2016) and includes studies analyzing complex environmental problems and their linkages to social systems (Perrotton et al. 2017; Song et al. 2021; Stokes and Selin 2016; Villamor et al. 2014).

The literature on RPS shows several benefits of applying this experiential method for research, communication and decision-making in natural resources management (Crampton and Manwaring 2014). Although RPS participants simulate specific roles, they can bring their creativity, spontaneity, and own interpretation of the simulated situation to enhance the collective experience (Susskind and Rumore 2013). RPS can allow traditionally silenced voices to be heard by the role-specific representation of those voices in the simulation and by encouraging participation in the negotiation by individuals representing groups typically left out of natural resource policy decision-making (Crampton and Manwaring 2014). RPS scholars have found that this experiential method may encourage more inclusive decision-making and participation in public policy design (Perrotton et al. 2017; Susskind and Rumore 2013).

Scholars in policy games use several frameworks to both design participatory research and understand the impacts of policy games on participants (e.g., Bela et al. 2016; Brummel et al. 2010; Chew et al. 2013; Fujitani et al. 2017; Gosen and Washbush, 2004; Ison et al. 2007; Lalicic and Weber-Sabil 2019; Leach et al. 2014; and Wenzler and Chartier 1999). Researchers have found that facilitated policy games contribute to participants' learning by enabling a better understanding of scientific information, encouraging empathy, and fostering tolerance to the 'other' and the other's positions, interests, and ideas about the problem (Perrotton et al. 2017; Wang and Davies 2015). Facilitation of policy games is key to allow diverse stakeholders, including voices often marginalized from decision-making, to be heard and have a voice in natural resource management (Campo et al. 2010; Susskind and Ashcraft 2010). To understand how policy games impact learning, we focus on collaborative learning, a participatory framework for improving environmental decision-making and policy development that brings diverse stakeholders to deliberate on complex social and ecological issues (Daniels and Walker 1996, 2001). Collaborative learning has received more attention in the environmental policy literature given expectations for increased participation of multiple stakeholders in environmental decision-making (Bela et al. 2016; Fujitani et al. 2017; McFadgen and Huitema 2017). This approach aims to facilitate collaborative dialogs between diverse stakeholders, encourage common understandings of complex topics, increase awareness of human-nature interdependencies, and elicit innovative responses to environmental problems (Banerjee et al. 2019; Thompson et al. 2010; Walker and Daniels 2019).

How policy games enhance learning is an underresearched area, and systematic methods for measuring the outcomes of participatory processes in natural resources management are also lacking (Baird et al. 2014; Gerlak et al. 2018; Haug et al. 2011; McFadgen and Huitema 2017). Interest in evaluating the learning effects of participatory processes in natural resource management stems from the assumption that participatory processes facilitate knowledge retention and contribute to social change (Angelstam et al. 2013; Lumosi et al. 2019). Building on the literature analyzing learning typologies, Haug et al. (2011) and Baird et al. (2014) propose the use of three dimensions of learning to evaluate the learning impacts of policy games. The first dimension refers to *cognitive learning* or changes in or improved factual knowledge (Lumosi et al. 2019; McFadgen and Huitema 2017). Cognitive learning involves changes in understanding of complex social-ecological systems and greater awareness of mutual interdependency between humans and ecosystems (Baird et al. 2014; Haug et al. 2011; McFadgen and Huitema 2017). According to McFadgen and Huitema (2017), cognitive learning is influenced by the "exchange of information, technical competency, and diverse information from a range of participants" (p. 650). The second dimension, *normative learning*, refers to changes in viewpoints, belief systems, norms, or values (Haug et al. 2011; Lumosi et al. 2019). Normative learning implies shifts in perspectives on problems and management options, changes in how learners perceive nature, social systems, or the human-nature relationship, or the development of agreements or consensus decisions (McFadgen and Huitema 2017). Policy games that involve negotiation through deliberation and joint work contribute to normative learning by facilitating the exchange of diverse perspectives, interests, and goals (McFadgen and Huitema 2017). The third and last dimension, *relational learning*, refers to "the social dimension of the policy exercise" (Haug et al. 2011, p. 976). Relational learning occurs when RPS participants are challenged by other participants' mindsets through active interaction and increased understanding of the other's interests (McFadgen and Huitema 2017). Relational learning may result in increased trust (in individuals, institutions, or both), increased understanding of others' perspectives (empathy), ability to cooperate with other individuals or groups, and building of relationships (Baird et al. 2014; Haug et al. 2011; Lumosi et al. 2019). In this paper, we use Sønderskov and Dinesen's (2016) definition of institutional trust to indicate "an individual's perception of the credibility, fairness, competence and transparency of state institutions" (p. 181). We employ these three dimensions of learning to measure the impact of a RPS method on participants' learning.

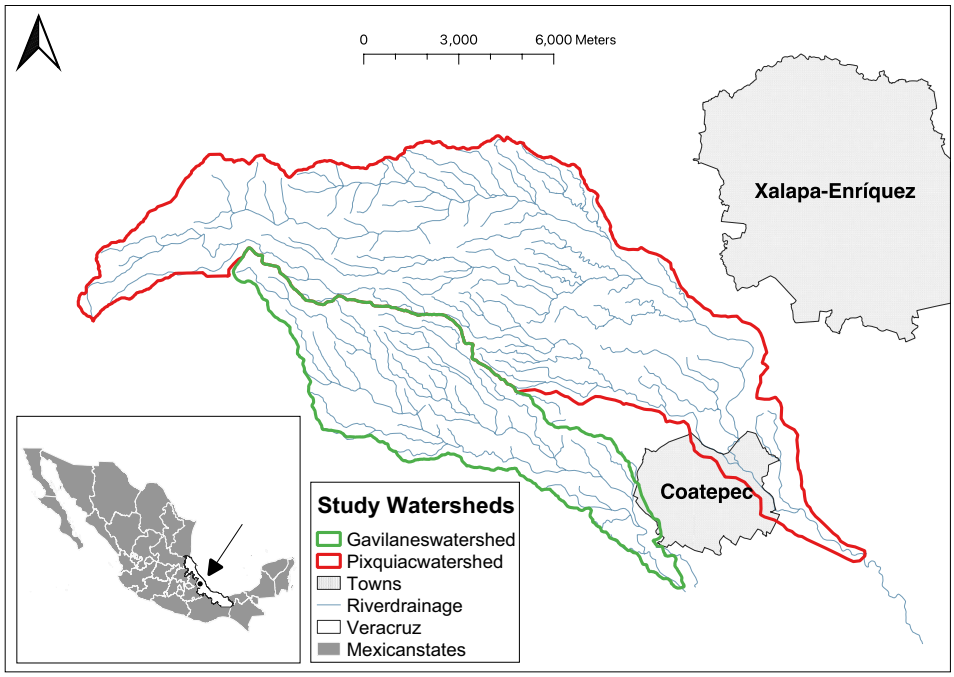

Fig. 1 Map of the study site

3 The case study: payment for hydrological services program in Veracruz, Mexico

Decreased water quality, increased flood and drought cycles, and overexploitation of aquifers prompted the Mexican government to address deforestation and forest degradation effects on hydrological processes via multiple state strategies, including mandatory conservation practices in forest areas and market-oriented policies to mitigate land use change in key watersheds that supply water to urban centers (Kosoy et al. 2008; Muñoz-Piña et al. 2008; Nava-López et al. 2018). Mexico's federal PHS Program, *Programa de Pago por Servicios Ambientales Hidrológicos*,[2] was launched in 2003 to incentivize forest protection and prevent land use changes in areas with high deforestation rates and water demand (Nava-López et al. 2018; Rodriguez and Ávila-Foucat 2013). This program is managed by the National Forestry Commission, *Comisión Nacional Forestal – CONAFOR*, with 2.5% of Mexico's federal water concessions managed by the National Water Commission, *Comisión Nacional del Agua – CONAGUA*, transferred into CONAFOR's Mexican Forest Fund, with supplementary funding eventually provided by the federal Congress (Alix-Garcia et al. 2009; Muñoz-Piña et al. 2008; Nava-López et al. 2018).In 2008, CONAFOR launched a second local matching funds PHS program, *Mecanismos Locales de Pago por Servicios Ambientales a través de Fondos Concurrentes*,[3] in an effort to increase funding and the participation by local stakeholders in managing forests and hydrological services (Jones et al. 2019; Nava-López et al. 2018). By 2016, CONAFOR reported 157 local matching funds contracts covering 515,454 ha (Pfaff et al. 2019). CONAFOR contributes up to 50% of the PHS matching funds and provides input on program eligibility criteria; local actors (i.e., local government, water utilities and water consumers) contribute the remainder of the program budget, select parcels for PHS, and monitor compliance (Pfaff et al. 2019; Sims et al. 2014).

We based our study on two local matching funds PHS programs in the cities of Coatepec (85,000 population) and Xalapa (425,000 population) in central Veracruz (Fig. 1) that were launched in 2002 and 2008, respectively. Both cities are located in the Antigua River watershed, which is predominantly characterized by tropical moist forest and tropical oak forest (Jones et al. 2019) and has suffered from water-related issues in recent decades due to conversion of land cover (Nava-López et al. 2018). Coatepec's PHS program covers the Gavilanes River sub-watershed and is administered by a local trust fund called *Fideicomiso Coatepecano para la Conservación del Bosque y el Agua* (FIDECOAGUA)[4] that

[2] See Mexico's National Forestry Commission website for a detailed overview of the federal PHS program (http://www.conafor.gob.mx:8080/documentos/docs/5/2290Servicios%20Ambientales%20y%20Cambio%20Climático.pdf.).

[3] A detailed explanation of the local matching funds PHS schemes in Mexico can be found in https://www.gob.mx/cms/uploads/attachment/file/126491/CNF-11_Servicios_Ambientales.pdf.

[4] See Nava-López et al. (2018) for an institutional analysis of FIDECOAGUA.

has strong participation from the municipality of Coatepec, the Municipal Water Commission (*Comisión Municipal de Agua Potable y Saneamiento de Coatepec – CMAS*) and local industries in program planning and decision-making. The Coatepec PHS program receives funding from CONAFOR, the government of Coatepec, CMAS Coatepec, and household water users (Nava-López et al. 2018). Xalapa's PHS program covers Pixquiac River sub-watershed and is administered by the local non-profit *Senderos y Encuentros para un Desarrollo Autónomo Sustanable* (SENDAS)[5] whose administrative approach has encouraged greater participation of enrolled landowners, water users, local agencies, and environmental NGOs (Nava-López et al. 2018). Xalapa's PHS program receives funding from CONAFOR, CMAS Xalapa, and the government of Xalapa. The contribution of household water users is voluntary. Federal PHS funds pay landowners to maintain forested lands only, thus PHS program administrators in both cities have looked for additional funding to incentivize environmentally friendly land uses and reforestation through complementary programs (Nava-López et al. 2018; Paré and García Campos 2018). Mexico's experience with PHS programs has been well studied by natural resource and social scientists who have evaluated their effectiveness and highlighted issues of program design, compensation, criteria for eligibility, monitoring, outreach, environmental communication, and education.[6]

4 Methods and participant demographics

4.1 Research design

Our study followed a pre-experimental design with assignment of participants to one group only (one-group pretest posttest design) (Campbell and Stanley 1963; Fujitani et al. 2017). We used a mixed-methods approach building on previous research on RPS applied to natural resources management to measure the learning effect of a RPS (Crampton and Manwaring 2014; Haug et al. 2011; Rumore et al. 2016; Stokes and Selin 2016). Our study combined an interactive negotiation (the RPS), group-based assessments (the debriefings), and self-reported assessments (workshop surveys and in-depth interviews) to understand the impacts of RPS on participants' learning.

4.1.1 The crystal river watershed payment for hydrological services negotiation

The Crystal River Watershed Payment for Hydrological Services Negotiation (see Urcuqui-Bustamante et al. (2022) for a description of the RPS) was implemented in two workshops with stakeholders from local matching funds PHS programs in the state of Veracruz. The first workshop was conducted in November 2018 in the city of Coatepec with participants from local and state government agencies, non-profit organizations, businesses, academia, landowners enrolled in PHS programs, and household water users. Recruitment focused on participation from a diverse range of stakeholders including PHS programs administrators, local and state agency staff, nongovernmental organizations and traditionally marginalized stakeholders in environmental planning and policy debates (i.e., household water users, private landowners and *ejidatarios* or landowners managing communal lands collectively). Participants were recruited through invitations and phone calls with the assistance of the local PHS administrators and a local university. We offered a modest compensation equivalent to one daily salary to upstream landowners only for attending the first RPS workshop. The second workshop was conducted in September 2019 in the city of Xalapa with stakeholders from local government agencies, non-profit organizations, landowners receiving payments from PHS programs and household water users. Recruitment for this workshop was done by the PHS program administrator directly and it focused on the city of Xalapa's PHS stakeholders, including household water users and *ejidatarios* enrolled in the PHS program. We did not offer a compensation for attending the second RPS workshop. Each RPS workshop lasted four hours in which PHS stakeholders participated in a simulated negotiation based on a hypothetical watershed and PHS program.

The RPS was designed using data from institutional interviews, household surveys and interviews, and biophysical research collected as part of a large interdisciplinary project (see Urcuqui-Bustamante et al. (2022) for a description of the simulation). The RPS scenario required participants to make decisions on the program design features and social-ecological targets of a hypothetical PHS program. The RPS scenario included a decision rule requiring consensus from most stakeholders in order for program administrators to act on the negotiators' decisions. Workshop participants were required to represent a fictional role (and navigate the role's interests and position) during the RPS negotiation. We designed seven PHS stakeholder roles including representatives from a nongovernmental organization, the federal agency of natural resources and forestry, a water and

[5] See Paré & Fuentes (2018) for an overview of Xalapa's PHS program and the role of SENDAS in administering the program.

[6] Further details about Mexico's federal PHS policy and PHS programs can be found in Alix-Garcia et al. (2009); Asbjornsen et al. (2017); Carter Berry et al. (2020); Jones et al. (2019, 2020); Kosoy et al. (2008); Muñoz-Piña et al. (2008); Nava-López et al. (2018); Paré & García Campos (2018); Rodriguez & Ávila-Foucat (2013); Shapiro-Garza (2020); Shapiro-Garza et al. (2020); Sims et al. (2014); Von Thaden et al. (2021).

sewer utility, and a private landowner, an *ejidatario*, two downstream water users, and a facilitator. We based the RPS design on the major PHS stakeholder groups from Coatepec and Xalapa and the program design issues most relevant for them. Workshop participants were assigned roles different from their actual roles to allow them to experience the negotiation from a different perspective. The facilitator role was played by a member of the research team.

4.1.2 Group-based assessments

A debriefing session was conducted after each workshop with all RPS participants. The debriefings were conducted in Spanish by a native Spanish speaker, audio recorded and later transcribed verbatim for qualitative analysis. Data collected through this method were used to gather individual and collective insights on how RPS negotiations developed during the game, what participants learned, and what surprised them about other people's roles and choices. We use the abbreviations "Deb18" and "Deb19" in this paper to indicate a speech segment extracted from the 2018 and 2019 debriefings, respectively.

4.1.3 Self-reported assessments

Pre- and post-workshop surveys were administered that combined a semantic differential scale, open-ended, and demographic questions to collect data about participants' opinions on, and knowledge of, PHS programs and the use of RPSs in negotiations. The semantic differential-type questions assessed participants' opinions on several cognitive, normative, and relational learning statements. The open-ended questions explored the three most important lessons participants learned during the RPS negotiation and the utility of the RPS for PHS decision-making. We assigned a survey code to the workshop instruments indicating the location of the workshop ("Coa" and "Xal" for the 2018 and 2019 workshops, respectively) followed by survey number.

Finally, we conducted post-workshop in-person interviews (interview code "Int" followed by interview number) with four RPS participants to collect more in-depth insights into participants' perspectives on the benefits and limitations of using RPSs in policy negotiations and how their perceptions of other PHS stakeholders' interests and concerns changed after playing the RPS. To recruit potential interviewees, we called and/or emailed all workshop participants who had given consent to be contacted for an interview after the workshop. All interviews were conducted in Spanish by a native Spanish speaker ten months after the workshop. The research design received IRB approval from Syracuse University (IRB No. 13–193) and the University of New Hampshire (IRB No. 7046).

4.2 Data collection instruments and measures

The pre- and post-workshop survey contained closed-ended, open-ended, semantic differential scale, and demographic questions (Urcuqui-Bustamante et al. 2021a). The questionnaire followed Haug et al.'s (2011), Baird et al.'s (2014), Stokes and Selin's (2016), and Rumore et al.'s (2016) instruments for assessing learning outcomes (Dependent Variable or DV) of interactive appraisal exercises (Independent Variable or IV). We used a five-point semantic differential scale to measure shifts in participants' perceived knowledge and viewpoints about several aspects of PHS program administration, design, and participation of diverse stakeholders. Measures along the five-point semantic differential scale ranged from low (ranks 1 to 3) to high (ranks 4 and 5) levels of agreement, importance, or knowledge. For cognitive learning, we measured changes in or improved factual knowledge including participants' perceived changes in overall knowledge about PHS programs and perceived effectiveness of PHS programs to protect water resources. To measure perceived changes in knowledge about PHS programs, we asked one general question in the pre-workshop survey and four theme-specific questions in the post-workshop survey (perceived knowledge about PHS programs, PHS program design options, PHS stakeholders' interests, and PHS program effectiveness). Data from these post-workshop survey questions were aggregated in a composite variable for analysis. To measure the perceived effectiveness of PHS programs to protect water resources, we used a single question in both the pre- and post-workshop surveys. For normative learning, we created a composite variable built on five questions or statements to measure shifts in viewpoints or beliefs about perceived importance of the financial sustainability of PHS programs, willingness of landowners to participate in PHS programs, willingness of water users to contribute to PHS budget, the role of science in proving the effectiveness of PHS programs, and financial contributions of different parties to the program. Finally, we created a composite variable built on two statements to measure changes in perceptions about program administrators and transparency in program budget administration to better understand the importance of trust among RPS participants.

The debriefing session of the workshop allowed for individual and collective reflections on the RPS experience. We asked RPS participants how their perceptions of PHS programs and other PHS program stakeholders changed during the negotiation. We also asked participants how they used scientific information, if they learned something new about other stakeholders, and if something surprised them during the negotiation. We based the debriefing on previous RPS research that suggests that group-based assessments are

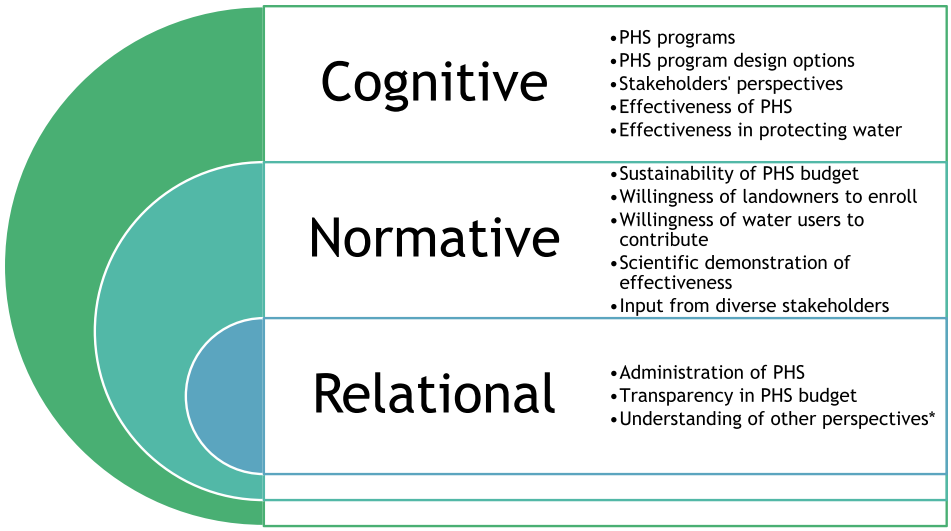

Fig. 2 List of themes measuring learning outcomes by learning dimension. (*) Indicates a recurrent theme identified and analyzed in the interviews, debriefings, and open-ended questions

needed to assess the interactions that occur in a social setting (Lalicic and Weber-Sabil 2019; Merlet et al. 2018; Rumore et al. 2016; Stokes and Selin 2016).

The post-workshop semi-structured interview asked for participants' perspectives on what they learned from the RPS, knowledge about PHS programs, and perceptions of other PHS stakeholders' interests (Urcuqui-Bustamante et al. 2021c). These interviews collected more in-depth insights into RPS learning outcomes associated with cognitive (i.e., knowledge about PHS programs, benefits, limitations, program effectiveness), normative (i.e., viewpoint on PHS program goals and water-related programs), and relational learning (i.e., understanding of other PHS stakeholders' perspectives and trust in program administration).

The analysis of qualitative data from the interviews, debriefing sessions, and open-ended questions allowed us to identify a recurrent topic (i.e., understanding of other perspectives) that was added to the list of themes measuring learning outcomes (Fig. 2) but was not included in the statistical analysis.

4.3 Data analysis

We analyzed quantitative data from questionnaires and qualitative data from transcribed RPS debriefings, responses to open-ended questions, and semi-structured interviews, to allow for triangulation from different data sources (Creswell and Poth, 2018). We used a paired sample *t* test (Student's t test) to compare sample means per DV (Campbell and Stanley 1963; Sprinthall 2011; Vaske 2008). A change in the mean scores of a DV before and after the workshop indicated a shift in participants' viewpoints or perceptions about PHS program administration, program design and contribution of diverse stakeholders to the PHS program (Fujitani et al. 2017; Haug et al. 2011). This statistical analysis tested the hypothesis of no real difference between the means of pre- and post-workshop group data (H_0) and higher mean of post-workshop versus pre-workshop group data (H_1) (Sprinthall 2011). We used Cronbach's Alpha to measure the reliability of the cognitive and normative learning composite scores, but not for the relational learning composite score because it was built on only two statements (Desselle 2005; Gliem and Gliem 2003; Spector 1992; Vaske 2008). The open-source software R version 3.6.1 (http://cran.r-project.org) was used (Maronna et al. 2019). Semantic differential scale data were treated as ordinal data. Missing data were not used in reporting the descriptive and inferential statistical analysis. Complete pairs were used for the pre- and post-survey statistical analysis to maintain internal validity.

Qualitative data from the transcribed RPS debriefings and answers to open-ended survey questions were analyzed using NVivo 12.1 for Windows 8 (Baird et al. 2014; Haug et al. 2011). A codebook was designed to categorize qualitative data into three types of learning impacts (cognitive, normative and relational learning) (Huitema et al. 2010; Lumosi et al. 2019; Munaretto and Huitema 2012). Initial coding was deductively conducted according to the research questions and literature in learning outcomes of interactive appraisal instruments. Analysis of qualitative data was then refined with focused coding to identify recurrent topics and/or ideas that participants raised during RPS debriefing and surveys (Emerson et al. 2011).

4.4 Demographics of the study participants

In total, 69 participants attended the 2018 ($n = 52$) and 2019 workshops ($n = 17$). The survey response rate across both workshops was 95.7% ($n = 66$). Demographic data show that 68% of RPS workshop participants were men ($n = 45$) and 32% were women ($n = 21$). Ages ranged

Table 1 Background of survey participant

	Statistics				
Variable	Categories		Count		Percentage(%)
Gender	Men		45		68.20
	Women		21		31.80
	Total		66		100.00
Academic level	No education		24		36.36
	Bachelor's degree		18		27.27
	Graduate degree		13		19.70
	Some college credit, no degree		6		9.09
	High school graduate		3		4.55
	Trade/Technical/Vocational training		1		1.52
	Didn't answer		1		1.52
	Total		66		100.00
Occupation or affiliation	Government, NGO, businesses		30		45.45
	Campesinos or farmers		18		27.27
	Didn't answer		18		27.27
	Total		66		100.00
Household income	Less than $2,500 MX		22		33.33
	Between $2,501 and $5,000 MX		6		9.09
	Between $5,001 and $7,500 MX		4		6.06
	Between $7,501 and $10,000 MX		7		10.61
	Between $10,001 and $15,000 MX		7		10.61
	Over $15,001		17		25.76
	Didn't answer		3		4.55
	Total		66		100.00
	Statistics				
Variable	Count	Min	Max	Mean	SD
Age	65	22	83	48.38	16.20

between 22 and 83 years with an average age of 48 years (Table 1). Workshop participants were diverse in terms of educational level, occupation, and household income. While a high number of RPS participants reported having either a bachelor's degree ($n = 18$, 27%) or a graduate degree ($n = 13$, 20%), a considerable number reported no education ($n = 24$, 36%). A small percentage of participants had taken a few college credits but obtained no degree ($n = 6$, 9%), were high school graduates ($n = 3$, 5%), or had received a type of trade, technical or vocational training ($n = 1$, 2%). In addition, RPS workshop participants reported employment with government agencies, nongovernmental organizations (NGOs), and local businesses ($n = 30$, 45.45%). At least 27.27% ($n = 18$) of participants self-defined as "*campesinos*" (peasants), "*agricultores*" (farmers), or "*propietarios dedicados al cuidado de la naturaleza*" (landowners who work for nature protection). Household income shows high variability among participants, with 33% ($n = 22$) of workshop participants reporting annual incomes of less than $2,500 MXN (~$114 USD in 2019) and 25.76% ($n = 17$) reporting income over $15,000 MXN (~$682 USD in 2019).

5 Learning outcomes of role-play simulations

5.1 Changes in perceived knowledge about PHS programs and effectiveness (Cognitive learning)

Shifts in perceived knowledge about PHS programs and their effectiveness to protect water resources reveal three important trends. First, pre-workshop data (Table 2) suggest low initial levels of knowledge and/or awareness about PHS programs among participants ($n = 53$, $M = 3.04$, $sd = 1.70$). During the RPS workshop, participants were informed about the goals of PHS programs and the process of implementing payments to landowners which elicited concerns about the lack of knowledge and/or awareness among urban citizens. For instance, a workshop participant who is an actual water user expressed displeasure about the lack of knowledge regarding the existence and specifics of PHS programs, "I didn't know about the existence of the program, and it really pissed me off" (Xal002). PHS program administrators and local government agencies often conduct environmental awareness campaigns to divulgate PHS program results and

Table 2 Shifts in average opinion about the level of agreement with and/or importance of statements by learning dimension (1–5 low to high)

Cognitive statements	Survey group[a]	*n*	Mean	SD	*t*-cal	*df*	*p*
Overall knowledge about PHS programs [b]							
	Pre	53	3.04	1.70	−3.240	52	0.002
	Post	53	3.95	1.10			
Knowledge about PHS learned in the game	Post	53	4.02	1.41			
Knowledge about PHS program design options	Post	53	3.83	1.44			
Knowledge about PHS stakeholders' perspectives	Post	53	4.00	1.34			
Knowledge about PHS program effectiveness[c]	Post	53	3.66	1.40			
PHS programs are effective in protecting water resources	Pre	54	3.15	2.15	−2.224	53	0.030
	Post	54	3.96	1.60			
Normative statements	Survey group[a]	*n*	Mean	SD	*t*-cal	*df*	*p*
Overall perceived importance of normative statements[b]	Pre	26	4.45	0.73	0.126	25	0.901
	Post	26	4.42	1.02			
Financial sustainability of PHS programs is important	Pre	27	4.48	1.19	0.116	26	0.908
	Post	27	4.44	1.37			
Willingness of landowners to enroll forested lands is important	Pre	56	4.14	1.66	−1.283	55	0.205
	Post	56	4.50	1.16			
Willingness of water users to contribute to PHS program is important	Pre	57	4.47	1.36	0.430	56	0.669
	Post	57	4.37	1.33			
Scientific proof of PHS program effectiveness is important	Pre	54	4.54	1.22	−0.315	53	0.754
	Post	54	4.59	1.00			
Contribution from all stakeholders is important	Pre	54	4.59	1.17	−0.558	53	0.579
	Post	54	4.70	0.90			
Relational statements	Survey group[a]	*n*	Mean	SD	*t*-cal	*df*	*p*
Overall perceived importance of relational statements	Pre	53	4.25	1.43	−2.154	52	0.036
	Post	53	4.74	0.84			
Who administers the PHS program is important	Pre	53	3.92	1.87	−2.385	52	0.021
	Post	53	4.60	1.18			
Transparency in how the program budget is used is important	Pre	57	4.54	1.36	−1.551	56	0.127
	Post	57	4.86	0.69			

[a] Pre: Participants' scores in pre-workshop survey. Post: Participants' scores in post-workshop survey

[b] Composite variable for post-workshop survey Group 2, includes the first three cognitive statements

[c] Variable is excluded from overall score according to Cronbach alpha analysis

inform water users of the existence of PHS programs at the city's utility payment location. However, the lack of awareness about PHS programs among workshop participants raises concerns for PHS program administrators about the effectiveness of the PHS program communication strategy.

A second finding was the perception of increased knowledge following the RPS. We first used Cronbach's Alpha (Appendix) to calculate the internal consistency of the cognitive learning scale that was used in the post-workshop survey. The results showed an improvement in reliability when the last variable (i.e., knowledge about PHS program effectiveness) was dropped from the calculation, leading to a Cronbach's Alpha of 0.72, which is considered high reliability (Desselle 2005). A paired *t* test on the composite variable for cognitive learning (i.e., overall knowledge about PHS programs) yielded statistically significant changes in perceived general knowledge (Table 2). The mean score of RPS participants' perceived knowledge about PHS programs increased from M = 3.04 to M = 3.95 ($n = 53$, $t = -3.240$, $p = 0.002$) after the RPS workshop, therefore, the null hypothesis (H_0 = there is no difference between mean scores pre- and post-survey group) is rejected at an alpha level of 0.002. Findings suggest that the RPS workshop improved cognitive learning through informing participants about PHS programs and giving them the opportunity to discuss PHS program design options. Increased knowledge about PHS programs and PHS program design options was highlighted by several participants who emphasized the importance of public forums to provide both information and direct interaction between key PHS stakeholders. One interviewee stated,

> "Since the [RPS] workshop, especially since I had the opportunity to deepen into the dynamics of being [a PHS program administrator], where I am

also part of, as neighbor, I had access to first-hand information from both the producer and those who administer the program from the city council, how this scheme works. And, well, [now] I even have the possibility to reach out to and locate them. I deepened and continue to deepen [my knowledge of the program]" (Int4).

This statement emphasizes two important perceived benefits of the RPS workshop. First, the RPS workshop informed participants about the existence of PHS programs, who the PHS program administrators are, the goals of PHS programs, and the design challenges program administrators face. Second, the workshop created a forum for deliberation and interaction between diverse PHS stakeholders that encouraged participants to become more interested in PHS programs. Findings suggest that the RPS workshop also impacted how participants perceive their relationship with ecosystem services, such as water resources, and other biophysical attributes. One RPS workshop participant highlighted changes in perceptions about the value of water resources beyond its utilitarian value,

"I learned quite a bit about the reality of the people who help us to deliver [water] resources. So, that knowledge that I did not have before [the workshop] and that I now have, allows me to recognize the true value of the water resource, not only in terms of tubes and valves, but also the value that this resource has as a vital liquid for conservation" (Deb19).

Third, we see that the mean score of RPS participants' viewpoint about the effectiveness of PHS programs to protect water resources had statistically significant differences between pre-workshop data (M = 3.15) and post-workshop data (M = 3.96, $t = -2.224$, $p = 0.030$), therefore, the null hypothesis (H_0 = there is no difference between mean scores of pre- and post-survey group) is rejected at an alpha level of 0.03 (Table 2). During the workshop, RPS participants discussed several limitations of PHS programs, such as minimal payments made to landowners, rigid standards for eligibility, and economic reductionism, and some of them reported, for example, that there was a "[…] need to adapt the program to include alternative and sustainable production schemes that make the support and effectiveness of the program more competitive" (Coa044) and that "the diversity of situations experienced in the countryside in Veracruz requires adjusting the PHS program to our reality" (Coa128). Given the perceived limitations of PHS programs, we might have expected no shifts in how participants perceived PHS program effectiveness, but interestingly participants' overall viewpoint changed after the workshop.

5.2 Changes in perspectives on problems and PHS management options (Normative learning)

Cronbach's Alpha was used to create a composite index for both pre- and post-data. For pre-workshop data, we found lower internal consistency ($\alpha = 0.52$) and that dropping two variables slightly increased the α to ~ 0.6 (Appendix). However, we found high internal consistency with all variables in post-survey data with $\alpha = 0.85$ (Appendix). To create similar indices, we kept all five variables in the composite index and used these for t test analysis. Results do not change if we only use the three variables in the composite index according to alpha analysis ($M_1 = 4.43$, $M_2 = 4.40$, $t = 0.133$, $p = 0.895$).

Overall, the RPS workshop did not lead to changes in normative learning (i.e., overall perceived importance of normative statements) ($M_1 = 4.45$, $M_2 = 4.42$, $t = 0.126$, $p = 0.901$) (Table 2). Although three out of five of the mean scores of the normative statements (i.e., importance of landowners' willingness to enroll forested lands, scientific proof of PHS program effectiveness, and contribution of all stakeholders) increased after the workshop at the 95% confidence level, no individual statements had statistically significant changes (Table 2). One reason for this might be that average scores were high (see mean scores of individual variables in Table 2) before the RPS and qualitative statements suggest that all program design issues were already important for workshop participants. For instance, financial contribution of all PHS stakeholders to PHS budget was perceived to be highly important by workshop participants before the workshop. During the workshops, many participants came up with several ideas for involving local businesses and industries, such as "It would be good for the industrial sector to get involved in decision-making, its participation could contribute to building public policies" (Coa113), and for increasing water fees to all water users, such as "We had consensus that all the extra money [budget] to cover all the new expenses should come from the water users" (Debrief19).

5.3 Changes in perspectives on relationships with other PHS stakeholders (Relational learning)

Findings suggest that the overall perceived importance of relational learning statements had statistically significant changes between the pre- and post-survey data (Table 2). The mean score of pre-survey group data (M = 4.25) has statistically significant differences with respect to the mean score of post-survey group data, (M = 4.74, $t = -2.154$, $p = 0.036$), thus the null hypothesis (H_0 = there is no difference between mean scores of pre- and post-survey groups) is rejected at an alpha level of 0.036. Data analysis suggests that workshop participants positively changed their

perception of the importance of PHS program administrators in managing PHS schemes and program budget. The active interaction of the RPS setting enabled workshop participants to experience a PHS negotiation from a perspective different from their own real-life roles and allowed them to recognize the important role of different PHS stakeholders, including PHS program administrators.

However, using *t* tests to analyze the two statements individually yielded different results. Our statistical analysis suggests that there was a shift in the viewpoint about the importance of who the PHS program administrator is (Table 2). Data show that the mean score of the pre-survey group (M = 3.92) has statistically significant differences relative to the mean score of the post-survey group (M = 4.60, $t = -2.385$, $p = 0.021$), resulting in a rejection of the null hypothesis (H_0 = there is no difference between mean scores of pre- and post-survey groups) at an alpha level of 0.021. However, we found no shift in the average opinion about the importance of transparency in how the program budget is used by program administrators. Although there was no statistically significant change, transparency in program budget administration was ranked high by a vast majority of workshop respondents before and after the intervention. It is worth noting that the mean score for this statement went up (from M = 4.54 to M = 4.86) after the RPS workshop.

The qualitative analysis shows that the RPS contributed to shifts in participants' viewpoints about others' interests and perspectives, and enhanced trust in PHS program administration. First, several workshop participants discussed that a key advantage of role-playing was "putting yourself in the other's shoes" which allowed participants to become aware of and learn about other's perspectives and needs. One interviewee reported that the RPS had several benefits such as allowing her to better understand the role of other PHS stakeholders and the challenges they face,

> "I believe that one of its [RPS] main advantages is to put yourself in other's shoes. I believe that this is one of its great benefits, because you finally understand the water operator, though the water operator doesn't play his/her role, but someone else does, but you begin to question yourself as if you were the water operator, or do you also understand the complexity of the mayor' role. You know that water is important, but I also have garbage, I have insecurity, and so on. And you might start agreeing that the [PHS] initiatives are indeed very good" (Int2).

By bringing together a diverse range of PHS stakeholders and encouraging them to represent different roles during the policy game, this RPS's experiential mechanism of "putting oneself in another's shoes" allowed some institutional participants to learn what other PHS stakeholders value about local ecological attributes. One RPS participant highlighted that non-profit representatives were surprised other PHS stakeholders do indeed value local watersheds,

"The NGO [representative] was surprised that other people did indeed have those ecological values deeply rooted, or an interest in protecting the environment, the river basin, and the environmental conditions of watershed. For them [the NGO] it was also very important, it was very attractive to know that other people also deeply value those natural resources that they have in their river basin" (Deb19).

Second, our findings also suggest that local PHS administrators can play an important role in enhancing PHS program effectiveness and improving social relationships between diverse stakeholders. Several RPS workshop participants agreed that PHS program administrators play a key role as program communicators and intermediaries between the government, the community, and environmental NGOs. During the negotiation, a group facilitator reported that her group had identified "lack of awareness and education about ecosystem services and PHS programs" as key limitations of PHS programs and, to improve programs, PHS program administrators and public officials needed to strengthen program budget transparency and communication mechanisms. Transparency was perceived as a key factor to improve PHS programs and motivate residential water users to contribute to the program,

> "We had an interesting discussion in which [the federal agency] asked for an increase of local actors' contribution [to PHS program budget]. Water users claimed similar situations to [the other RPS negotiating table's claims] where they argued that they were interested in increasing the residential water user fee, but with the condition of better transparency about resource management, but especially that the economic resource does not go through the agency, but directly to the beneficiaries of the program" (Deb19).

Transparency was directly tied to program budget administration by a survey respondent who argued for, "An institutional commitment to monitoring and good management of economic resources" (Coa119). Another RPS participant stated, "There must be two conditions [for increasing the water use fee]. There must be a lot of information and awareness of [the need of contributing to the PHS program], and, on the other side, there must be transparency in the administration of the [economic] resources so they [water users] will contribute [to the program]" (Deb19). These statements highlight that RPS participants value transparency in program budget administration and the need to work toward better mechanisms to inform the public about PHS program issues.

Finally, the RPS experience challenged workshop participants by asking them to represent a role different from their actual role, and by having them negotiate pre-established

PHS program design options and make collective decisions on new PHS program design options. Some RPS participants highlighted that the RPS method contributed to creating new options for the PHS program that would consider diverse interests and needs. For instance, a survey respondent wrote in the questionnaire that the RPS was useful "because creative options are generated; empathy and understanding of more variables in the complexity of the situation [increase]" and that playing a different role from their own was important to understand other perspectives, "how important it is to put yourself in the shoes of each actor to build solutions that consider everyone's concerns" (Xal007). The RPS encouraged participants to collectively brainstorm, negotiate, cooperate, and find common ground, and finally decide between a list of PHS program design alternatives and identify those which best fit their needs and interests as a group. In this sense, RPS participants noticed the utility of the negotiation for collective decision-making, "it offers the opportunity to listen to different points of view and needs of actors to make decisions based on a collective and consensus vision as far as possible" (Coa044). Another workshop participant similarly stated that the RPS allowed them to understand PHS scenarios and focus on what they wanted to achieve, "because with the negotiation we can see future scenarios and focus on where we want to be" (Xal009).

As an experiential approach, the RPS revealed several factors (such as mutual understanding, trust in the PHS program administrator, and transparency in the management of the PHS program budget) that could potentially impact participants' ability to cooperate in environmental decision-making and policy design. However, determining if the RPS effectively impacts participants' relational learning would require additional research that measures long-term and real-world impacts.

6 Key insights from a science-based role-play simulation

The literature on policy games often recommends using RPS as a means to foster participation and dialog between state and non-state actors about environmental issues such as forest degradation, water management, and natural resources administration, yet few studies have empirically and systematically tested this recommendation (Baird et al. 2014; Haug et al. 2011; Rumore et al. 2016; Susskind et al. 2015; Susskind and Rumore 2013). Our study design aimed to advance the practice of collaborative learning by implementing an experiential method of stakeholder engagement in environmental decision-making and applying a measurable tool to assess learning outcomes (cognitive, normative, and relational learning). Our study created a forum to discuss and negotiate PHS program design options that engaged diverse stakeholders, including actors not often engaged in PHS decision-making (Urcuqui-Bustamante et al. 2021b). The RPS workshop was seen by participants as a mechanism for social exchange that allowed different stakeholders to interact and work toward improved environmental programs. As described by several interviewees, playing the role of a different PHS stakeholder allowed them to have a sense of an "immersive situation" in which understanding the other's perspective led them to feel empathy and deep learning beyond technical PHS program dynamics (Bellotti et al. 2010; Crampton and Manwaring 2014; Perrotton et al. 2017; Stokes and Selin 2016). This sense of being in an immersive situation has been described by several policy games scholars as both an outcome and a means of fostering collaborative processes where learning is embedded in relational aspects of knowledge exchange, dialog, and group work (Angelstam et al. 2013; Haug et al. 2011).

Policy games such as RPS allow participants to learn from simulated real-life situations by emphasizing "the experiential, embedded nature of learning and stress its relational aspects" (Haug et al. 2011, p. 970). Learning through policy games occurs when stakeholders are challenged by other stakeholders' perspectives, work jointly to find solutions to common problems, and make informed decisions through participatory means (Baird et al. 2014; Haug et al. 2011). Policy games foster a learning space where participants benefit from having direct contact with other stakeholders (Haug et al. 2011; Rumore et al. 2016; Stokes and Selin 2016). Our study design showed that a RPS that required consensus incentivized collaborative learning among participants by fostering a safe, collaborative multi-stakeholder negotiation of a hypothetical PHS program (Lumosi et al. 2019; Walker and Daniels 2019). The recruitment strategy of collaborating with actual PHS program stakeholders and a local university to invite participants was successful in bringing a diverse set of PHS program stakeholders (see Urcuqui-Bustamante et al. (2022) for a description of the RPS workshop participants). Through active facilitation, workshop participants were allowed to have a voice in the PHS negotiation and be represented by one of the hypothetical roles. RPS participants highlighted the learning benefit of the RPS workshop by bringing together diverse stakeholders and facilitating discussions about an environmental program (Song et al. 2021).

6.1 Collaborative learning through a policy game

Policy games, such as RPS, have been used to foster learning among a diverse range of participants with the assumption that RPS enriches learning outcomes through knowledge acquisition, challenges common beliefs and perspectives, and fosters experiencing real-life situations through other people's lenses (Susskind 2014; Susskind et al. 2015; Susskind and Rumore 2013). Our study design and learning

typology provided measurable indicators to better understand the impact of the RPS negotiation on participants' learning (Angelstam et al. 2013; Baird et al. 2014; Haug et al. 2011). Considering the three dimensions of learning, we found that the RPS impacted participants' learning in different ways. First, we found that the negotiation forum improved participants' perceived cognitive knowledge about PHS programs and PHS program design issues by providing information about PHS policy scenarios and direct interaction with key stakeholders (Baird et al. 2014; Lumosi et al. 2019; McFadgen and Huitema 2017; Susskind, 2014). Haug et al. (2011) argue that RPS is an effective educational tool to increase cognitive learning about complex scientific information and to increase knowledge about ecosystem services and environmental issues.

Second, our findings suggest that relational learning did occur by "putting participants' in the other's shoes" and allowing knowledge exchange and collaborative dialog between diverse PHS stakeholders. This study's focus on learning through interaction between individuals (Vinke-de-Kruijf and Pahl-Wostl 2016) elicited improved understanding of others' perspectives and enhanced trust/transparency which are key to building relationships. Bela et al. (2016), Perrotton et al. (2017) and Susskind and Rumore (2013) have found that RPS can improve social relationships between community, scientists and state actors and may have the potential to encourage participatory design of public policy. However, as stated by Haug et al. (2011, p. 976), these findings in relational learning are limited, as building trust and the ability to cooperate require long-term engagement processes (e.g., communities of practice or collaborative networks) that allow us to understand how relationships develop and have impact on existing PHS programs and environmental decision-making.

Third and last, we found that, overall, normative learning did not occur as an outcome of the RPS workshops. Our findings echo Baird et al.'s (2014) conclusion that it is unlikely that changes in values and viewpoints would occur as a consequence of short-term interventions, such as a four-hour RPS workshop, and that, on the contrary, these tend to change very slowly. However, social scientists have suggested that studying shared values in the context of PHS programs can aid in understanding the social impact of economic approaches to conservation (Irvine et al. 2016; Kenter et al. 2015). For instance, researchers can identify the shared values of ecosystems to local communities and analyze how these values develop and are understood through engagement processes.

Findings also suggest there were low initial levels of knowledge about PHS programs, especially from household water users. Given that the two real-world PHS programs in our study area have been operating in the cities of Coatepec and Xalapa for the last 19 and 13 years, respectively (Muñoz-Piña et al. 2008, 2011; Paré and Fuentes 2018), we might have expected greater knowledge and/or awareness of the existence and/or implementation of PHS programs among citizens. PHS program administrators and governmental agencies promote PHS programs and communicate their results with the public through environmental awareness campaigns and, in some cases, through the engagement of key stakeholders in environmental planning, participatory action research, and PHS program decision-making (Paré and Fuentes 2018). However, our findings suggest PHS program administrators and local officials need to address the lack of awareness and/or knowledge of the existence of a PHS program in the study area to improve communication and inform the public about PHS outcomes.

6.2 Insights for future research in PHS and policy games

Although our study design was based on triangulation of diverse sources of data (Creswell and Poth 2018), some limitations need to be acknowledged. First, more active speakers tend to dominate the discussion in public spaces, thus limiting other voices from being heard during a debriefing (Braasch et al. 2018; Farrié et al. 2015). The research team actively facilitated the RPS workshop to allow for participation from underrepresented stakeholders in decision-making, however, encouraging active participation from these stakeholders was challenging during the RPS and post-workshop debriefing. Second, the low response rate for the follow-up interviews (16%, $N=4$) did not allow for broader, in-depth analysis of learning outcomes. Third, the lack of a control group (no treatment group) may have induced workshop participants to modify their opinions (perceived importance) about learning statements in response to their awareness of being assessed through a post-workshop survey (Hawthorne effect). This may have affected internal validity because we cannot completely rule out that changes after the RPS were not due to some other factor. Fourth, some participants dropped out from the study during and/or after the workshop (attrition). To address this, we suggest either 1) surveying PHS stakeholders in the area to assess their knowledge about PHS program and attitudes toward several PHS program design issues and then take a sample from this population to play the simulation, or 2) using a control group to compare the effects of this policy game across different forms of dialogic interactions and at different locations, for instance, building a more standard one-way communication strategy, such as a formal presentation about PHS programs, and comparing the learning outcomes of the treatment (RPS) and control (formal lecture) groups. Finally, the study is not generalizable to an extended population in central Veracruz

due to convenience sampling and/or sampling bias (Baird et al. 2014; Haug et al. 2011).

It is also important to mention that, as more attention is paid to forest degradation and related hydrological services (Asbjornsen et al. 2015), citizen and state pressure increases to adopt innovative methodologies to incentivize environmentally friendly practices (Engel et al. 2008; Jones et al. 2019) that require understanding of complex technical concepts (i.e., hydrological services, PHS program dynamics), diverse PHS program design options and multiple PHS stakeholders (Hayes et al. 2019). We argue that RPS offers a useful mechanism for implementing participatory design processes by bringing together diverse stakeholders to engage in policy negotiations and problem-solving about complex environmental concepts (Lumosi et al. 2019; McFadgen and Huitema 2017; Rumore et al. 2016; Stokes and Selin 2016; Susskind et al. 2015). We suggest the use of consensus-based policy games by local PHS operators and government agencies to foster engagement of PHS stakeholders in program design.

The literature in policy games applied to natural resource management has shown their impact on learning when participants are actively exposed to scientific information and complex decision-making situations (Baird et al. 2014; Haug et al. 2011; Rumore et al. 2016; Stokes and Selin 2016). While measurement of learning impacts of policy games is still an understudied area, our research sought to advance scholarship in this area by providing a set of metrics and a methodological framework to evaluate learning outcomes of PHS-type policy games. In addition to demonstrating cognitive learning benefits of policy games, we found that RPS has potential for illustrating how relational learning works in social settings and what aspects of institutional trust should be considered by PHS program administrators. Trust in PHS program administration, the perception of transparency in PHS budget administration, and the ability to understand others' perspectives are key components of institutional trust that need to be considered in environmental planning and decision-making by organizations leading PHS programs. Future research should incorporate other aspects of institutional trust to assess relational learning outcomes of policy games, such as perceived trust between individuals and organizations, perceived ability to cooperate with other individuals or groups, perceived credibility and transparency of stakeholders in PHS program administration (Baird et al. 2014; Lumosi et al. 2019; Sønderskov and Dinesen 2016).

Although the Crystal River Watershed Payment for Hydrological Services Negotiation was adapted from two real-life case studies, the RPS can be applied to different PHS contexts, and with different stakeholders, where learning is a key element to improve PHS program effectiveness and/or there is actual need to evaluate diverse PHS program design options (Urcuqui-Bustamante et al. 2022). If actual PHS stakeholders are involved in designing these simulations, program administrators and government agencies will be informed about individual and collective perspectives on PHS programs focusing on what aspects of PHS program design and administration need to change and/or improve (Crampton and Manwaring 2014; Urcuqui-Bustamante et al. 2021b). In addition, as RPS recreates "key dynamics and challenges of real-world activities" (Crampton and Manwaring 2014, p. 2), it can be used as a tool for collaborative learning for actual stakeholders and program administrators to catalyze more participatory processes and/or as a tool for stakeholder engagement practice (Urcuqui-Bustamante et al. 2022). Following Crampton and Manwaring (2014), Stokes and Selin (2016) and Susskind (2014), we also suggest the use of RPS in instructional settings to contribute to students' understanding about the process of complex real-life negotiations and to prepare students for facilitation challenges in their stakeholder engagement practice.

However, careful attention is needed to adapt the game (policy questions, game roles, etc.) to the local context where actor roles and other factors will differ from our RPS. For instance, the role of the *ejidatario* would need to be clearly explained to workshop participants so they can understand the community and individual rights attached to this type of land tenure. Furthermore, contextual factors such as social structures, institutional constraints, legal norms applied to PHS programs, administrative bureaucracy, social conflicts, and power structures in decision-making need to be considered in order to incorporate key findings into PHS program improvement (Reed et al. 2018; Sprain 2016; Urcuqui-Bustamante et al. 2021b). Several authors have called for attention to the ways stakeholder participation in environmental planning and decision-making tend to reproduce power inequalities and inequities by not allowing meaningful and effective consideration of engagement outcomes into real-world decisions (Sprain 2016; Sprain et al. 2011). We suggest that researchers and practitioners in stakeholder engagement should carefully explain the goals and scope of the use of policy games and what the expectations are embedded within existing power structures. The Crystal River Watershed Negotiation has great potential for stakeholder engagement and fostering learning, but it needs to be clearly incorporated into a broader institutional strategy for research and practice on stakeholder engagement.

7 Conclusion

There is a growing need for researchers and practitioners of stakeholder engagement to understand the impacts of engagement processes on actual stakeholders and environmental decision-making. We responded to this inquiry by engaging diverse stakeholders in a hypothetical

decision-making situation about the design features of a PHS program. We assessed the learning outcomes of a role-play on participants' cognitive, normative, and relational learning. Although there were no statistically significant changes on normative learning (e.g., values about ecosystem services and importance of several program design options), we found that RPS improved participants' perceived knowledge about PHS programs and program design features and fostered mutual understanding and enhanced trust between workshop participants. This paper contributes a set of metrics and a methodological framework to evaluate learning outcomes of PHS-type policy games that we hope will aid in further evaluations of the impact of RPSs on participants' learning. Future research should adapt the RPS to local contexts by modifying RPS roles and policy questions, and the set of learning metrics to measure other components of the learning process, such as measuring changes in the level of trust in governmental agencies or PHS program administrators and measuring changes in values associated with ecosystem services.

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Declarations

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