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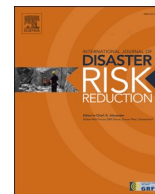
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# Fostering collaboration in city governments' sustainability, emergency management and resilience work through competency-based capacity building

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## ABSTRACT

Cities are challenged by climate change, natural and technological disasters and related injustices. At least three fields address these challenges within cities: sustainability, emergency management and resilience. However, these three fields often still work in silos, separated by administrative structures. One way to promote a synergistic and integrative city-level approach across the three fields is through actively fostering collaboration. This can be facilitated through a competency-based capacity building program. So far, only few capacity building programs attempted to foster collaboration across departments and fields. To address this gap the researchers collaborated with the City of Tempe, Arizona, USA to implement a program that addresses the respective sets of competencies and concepts in these fields. The question was asked how these competency sets and concepts can be integrated into one capacity building program to support collaboration across departments. The focus was on emergency management and sustainability competencies respectively, as a literature review revealed paucity of a resilience competency framework. Three capacity building trainings were implemented and competency development was evaluated using a pre-post survey and analysis of training interactions. The results show that: i) overall collaboration across departments was facilitated; ii) participants demonstrated sustainability and emergency management competencies in at least one of the three trainings, iii) participants were satisfied with the trainings individually and combined into one training program. The work concludes with recommendations to increase the development of collaborative competencies and to foster collaboration in practice in the long-term as part of “institutional work” in order to influence administrative structures as well.

## 1. Introduction

Cities, home to most of the world's population, face major challenges such as climate change, biodiversity loss, increased costs from damages due to disasters and the fact that the adverse effects of climate change and other unfolding disasters are inequitably distributed, affecting vulnerable populations the most [1–6]. The number of natural hazards leading to increasingly complex and compounded disasters has sharply increased in the last decade and more incidents are forecasted with increased frequency and intensity [7–9]. In the absence of federal action, cities accelerate climate action by committing to reducing

greenhouse gas emissions as exemplified in the Global Compact of Mayors [3].

Urban sustainability, emergency management and urban resilience are three fields primarily focused on addressing these urban challenges. Although the three fields have distinct foci and functions in addressing urban challenges, they are closely interlinked – in theory. In practice, realizing a complementary and collaborative approach presents major challenges. In the following the foci of each field and their complementarity to each other are discussed and applied in practice. The latter is done in form of a capacity building program that aims to foster collaboration by developing competencies needed for collaboration

*Abbreviations:* SC, Key Competencies in Sustainability or sustainability competencies; EMC, Next Generation Core Competencies in Emergency Management or emergency management competencies.

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(‘collaboration through competencies’) and having a diverse group of participants engage with each other through collaborative activities (‘collaboration through activities’). The goal is to promote an integrated collaborative city government that addresses urban challenges holistically by connecting their emergency management, sustainability, and resilience work.

Urban sustainability aims for normative goals of social equity, economic viability, and integrity of socioecological systems in the short- and long-term. To achieve these goals, sustainability approaches focus on addressing root causes of systemic problems like vulnerability [10] through sustainable activities including i.e. long-term fiscal sustainability and economic competitiveness, resource efficiency, low carbon emissions, disaster resilience, and social justice and inclusiveness [11]. In contrast, cities’ conventional activities often address limited aspects of sustainability, reflecting an insufficient understanding of the multi-faceted sustainability issues [12]. An example is (urban) policies promoting environmental goals at the expense of equity goals, which promotes gentrification [13].

Emergency management aims at avoiding, mitigating, responding to and recovering from natural and human-caused hazards [14]. Emergency management activities are generally associated with creating a culture of preparedness within city governments and communities [15]. Additionally they work towards mitigation and post-disaster recovery while reducing complexity of emergency management processes related to mitigation, preparedness, response, and recovery [14,15]. Yet, cities’ emergency management focus remains primarily on preparedness and response [16,17]. Meanwhile investments into mitigation and risk reduction measures would be more cost-effective [18,19] and ways to integrate these measures into urban development plans exist [20]. Nevertheless, persisting gaps in integrating disaster risk research and practice, specifically the limited integration of research findings into policy, hinder successful recovery and cause rising economic losses that remain unaddressed [21]. The terms emergency management and disaster (risk) management are used synonymously in the following.

Urban resilience aims at adapting, maintaining or rapidly returning to desired functions in the face of disturbance [22]. Moreover, a city’s resilience involves its ability to absorb as well as learn from stressors (such as rapid urbanization or increasing equity gaps) and shocks, such as heat waves or economic recessions [23]. Yet, conflicting definitions of resilience create tensions and a lack of clarity [22,24]. This paper follows the definition of resilience within cities by Meerow et al. (2016) [22]. Urban resilience is “the ability of an urban system [...] to maintain or rapidly return to desired functions in the face of a disturbance, to adapt to change, and to quickly transform systems that limit current or future adaptive capacity” [22 p. 39].

Recently, resilience has emerged as the dominant concept for urban development, often replacing sustainability [25]. This is likely a consequence of the flexibility of resilience as a concept [24]. Nevertheless, sustainability and resilience are best understood as intertwined and mutually reinforcing [15,25]. They are distinct yet complementary approaches that should be pursued jointly [26], especially as resilience has become crucial to foster sustainable development [23]. In addition, resilience emerged as a common aspirational goal of emergency management [25,27] and contributed to shifting its focus from response to mitigation as resilience emphasizes communities and sustainability [28]. Scholars posit that emergency management ought to be organized around sustainability, which provides the intra- and inter-generational perspectives bringing values and ethical issues to the forefront when considering current and future-oriented risk reduction activities [29].

Despite these interlinkages and respective calls for coordination and collaboration across the three fields in the literature, there remains a lack of collaboration across departments in practice; the three fields continue to work predominantly in silos as historically defined [30–32]. As a result, city departments develop fragmented solutions to complex challenges making it more difficult to coordinate across fields and departments, hindering the solutions’ effectiveness and long-term success.

Meanwhile, collaboration across sustainability, emergency management and resilience is required to address the range of complex challenges cities will face, as no field alone holds the capacities to cover the full range of challenges [33].

To address the complexity of these challenges, city staff and leadership are required to build new capacities and silo-crossing skills that enable taking effective and transformative action [34,35]. The need for silo-crossing and a conversation around their existence within all levels of government and across all fields can be seen as a first step towards an integrative, collaborative and transdisciplinary city government.

There are multiple approaches for creating collaboration within a city government. Silo-crossing approaches include integrating planning processes, breaking down bureaucratic barriers, establishing what shared problems are and seeking joint solutions, all of which require reinventing administrative structures [28,31,36]. Reinventing administrative structures and building new capacities result from so called *institutional work*, a concept connecting organizations with individual agency [37]. Institutional work refers to the actions of organizations and individuals that create, maintain, and disrupt institutions, i.e. formal and informal rules, and procedures [38]. These actions can be purposive, deliberately aimed at changing institutions or non-purposive, unintendedly affecting institutions [39]. The researchers argue capacity building is a part of the institutional work necessary to facilitate the kind of deliberate behavioral and procedural changes needed for collaboration (through competency development and collaborative activities) across the three fields.

### 1.1. Capacity building through serious games to increase collaboration

Capacity building in the context of city governments refers to the overall ability of an individual or group to perform their responsibilities within the local government [40]. To this end, it refers to activities of individuals and groups to *strengthen* their knowledge, abilities, and skills (summarized as *competency*), to *improve institutional structures* as well as to *address material and logistical constraints* in order to achieve the organization’s intended goals [34,41]. Considering the elements highlighted in *italic* of this definition, it becomes clear why the terms ‘capacity building’, ‘capacity development’, ‘institutional and organizational development’ and ‘institutional capacity building’ are often used interchangeably [42]. Capacity building ought to be connected to the larger work contexts, so that capacity building trainings are not just a one-off activity but support building human and institutional capacity for lasting change [43]. Thus, capacity building refers to the *process* of changing/improving the performance of local organizations by addressing human capital and institutional resources to achieve the goal of connecting emergency management, sustainability and resilience.

Competency development on the other hand focuses on the development of competencies, which are made up of functionally related knowledge, skills, and abilities, that enable successful task performance and problem-solving [44]. Competency development is a part of capacity building and helps to enable collaborative behavior in participants by building their skills, knowledge, and abilities (‘collaboration through competencies’). This foreshadows section 1.2 where the competency element will be explored more.

Capacity building approaches that incorporate serious games seem promising to foster collaboration. Serious games are used primarily for educational purposes, not for entertainment [43,45–47]. Therefore, they are utilized as building blocks of the capacity building program in this research and as tools to facilitate competency development and learning about concepts in emergency management, sustainability, and resilience. Serious games create a space for diverse groups to “enhance understanding, reconcile different views, and potentially assist each other in meeting their respective goals” [47 p. 1]. This helps overcome challenges related to organizational structures, divergent concerns, and occasional competing agendas of stakeholders with diverse backgrounds [47]. Serious games are “designed for, and implemented across,

disciplines, skills, backgrounds, positions and many other ‘demographic’ factors” [46 p. 13]. This shows their potential to foster collaboration, especially in the three fields of sustainability, emergency management and resilience, which are the focus of this research. Serious games often employ role-playing to simulate hands-on decision making and facilitate discussions on sensitive and complex issues within a city government in a playful manner [43,47]. They do so by evoking interest in the newly introduced capacity and concepts, enhancing the process of remembering information as well as fostering engagement, boosting confidence and building trust whilst giving participants a holistic view of an issue, challenge, emergency situation or risk [43,46–49]. They are thought to be especially useful for a collaborative and adaptive response of participants, as serious games facilitate an ongoing dialogue and a shared language to ensure that actors have the same understanding on different topics and issues [43,50].

In the context of emergency management, serious games raised awareness of disaster risks across diverse audiences, helped identify hazards and preventive actions, and triggered empathy by simulating disasters in realistic ways [43]. While serious games are a tool for informing adaptive governance approaches to environmental problem-solving within all levels of local governments, they often fail to involve the community and high-level decision makers (e.g. city council), whose support of proposed action is critical [46]. Yet, serious games in the sustainability and resilience realm have tried to bridge that gap (c.f. Keeler et al., 2017 [48]).

Most importantly however, serious games provide opportunities for joint activities that help to improve collaboration and collaborative behaviors amongst participants (*‘collaboration through activities’*).

### 1.2. Competencies in sustainability, emergency management and resilience

In this project, serious games are combined with competency-based trainings to reflect shifts towards competency-based degree programs in higher education and competency-based trainings for professionals. This approach combines the two elements of fostering *collaboration through activities* and *through competencies* (knowledge, skills, and abilities), as competencies for collaboration are directly entailed.

Competencies frameworks have been consolidated for both, sustainability and emergency management degree programs through independent efforts [44,52].<sup>1</sup> These frameworks clarify the competencies that graduates from these programs are expected to bring to the workforce, specified for different levels of mastery (i.e. undergraduate, master, doctoral level). Preliminary proposals for linking the two competencies frameworks in higher education programs have been made (c.f. Brundiers, 2018 [51]). Additionally, competencies frameworks have been increasingly applied to the professional setting in form of trainings (c.f., Keeler et al., 2017 [48]) which is built upon as part of this research.

Fig. 1 presents the competencies frameworks, showing the Key Competencies in Sustainability on the left, the Next Generation Core Competencies in Emergency Management on the right and their relationships to each other.

Sustainability competencies (SC), the so called *Key Competencies in Sustainability*, comprise of values-thinking, futures-thinking, systems-thinking, strategic thinking, collaborative competency, and integrated problem-solving competency [44,53]. They are the result of a literature synthesis, which identified these six interrelated SC. Intrapersonal and implementation competencies are competencies that were recently proposed to be added to the framework [54]. The goal of the SC is to develop sustainability change agents, able to implement transformative

actions within any setting [44,53].

Emergency management competencies (EMC), the so called *Next Generation Core Competencies in Emergency Management*, include three nested core competency categories: 1) Competencies that Build the Individual (Operate within the Emergency Management Framework, Possess Critical Thinking, Abide by Professional Ethics, Continual Learning), 2) Competencies that Build the Practitioner (Scientific, Geographic, Sociocultural, Technological, and Systems Literacy) and 3) Competencies that Build Relationships (Disaster Risk Management, Community Engagement, Governance and Civics, Leadership) [52,55]. The EMC have the goal of guiding future emergency managers to build capacities for disaster risk reduction and aiding resilient communities [55].

Fig. 1 also shows the structure of the two frameworks, including their relationships, elements, and terminology. Regarding their relationships: while EMC are hierarchically nested in their categories, the SC are functionally related. Regarding their elements: EMC are described by Behavioral Anchors and their Key Actions (incl. behaviors that demonstrate competency) [52]. SC are described by aspects (incl. concepts/theories and methods) which are operationalized by learning objectives for performance measures [53]. These elements, although worded differently, fulfill similar objectives in their use and definitions (see = in Fig. 1 and Bhagavathula, 2020 [56] for in depth analysis). While collaborative competencies are particularly interesting when fostering collaboration in a professional setting, mastery of all competencies combined can increase collaboration within city governments more holistically and long-term. Collaborative competencies can facilitate silo-crossing as a first step. In order to break down silos, collaborative competencies need to be combined with all other competencies to create holistic approaches. An example hereof would be the attempt to create a more just and inclusive participatory planning process to develop strategies for equitable urban development. This would involve collaborative competency as well as systems-thinking competency (analyzing location-specific hazards and racial inequities), futures-thinking competency (scenario development and visioning), and values-thinking competency (identifying and reconciling diverse value sets, while anchoring equity). Therefore, all competencies are included in this research (besides intrapersonal and implementation competencies, as they were not yet published at the time of this research).

Lastly, resilience competencies could not be integrated into the project. This is due to the fact that competencies for resilience are not yet solidified as the definition of resilience is still charged with tensions [22]. Resilience as a concept was still reflected as part of this work as applicable.

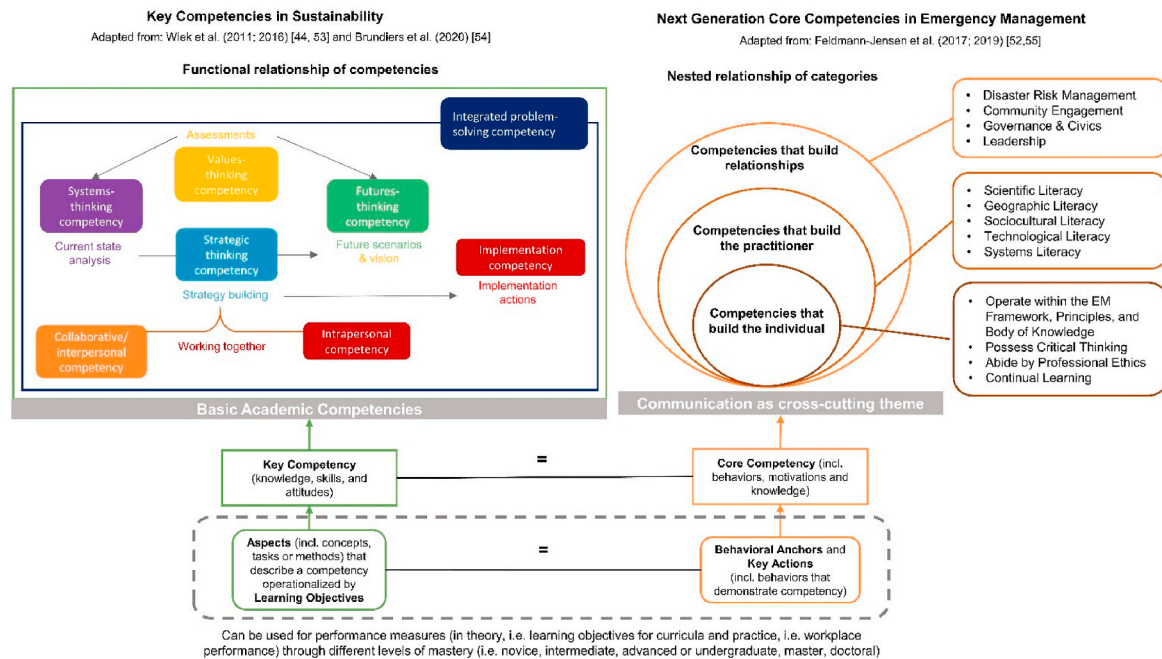
For this project, serious games designed to facilitate development of these competencies among professionals were investigated in efforts to select those applicable to a US context, as this research is based in Tempe, Arizona, USA (see methods section, 2.1). Serious games facilitating SC development include “AudaCITY” [57] and “Future Shocks and City Resilience” [48]. Both were specifically designed to facilitate SC development; the latter is one of the few trainings that connects SC to the concept of resilience.

An example of a serious game on emergency management in a US context is the table-top training “The Whole Community: Planning for the Unthinkable” [58]. Table-top simulation exercises are commonly used in international settings as well, such as the “simulation exercises” provided by the World Health Organization [59], the “games” by the Red Cross/Red Crescent Climate Centre [60] or the collaborative training platform “In-Prep” by the European Union [61]. So far, no serious games were found that specifically included EMC in their training design.

### 1.3. Research objective and research questions

This research project addresses the gap in the reviewed literature in the three fields on how to integrate the competencies frameworks in

<sup>1</sup> The literature review revealed that for sustainability and emergency management competencies in higher education, the two frameworks presented here are the only two competencies frameworks in either field published in literature up to the time of this research.



**Fig. 1.** Overview of the Key Competencies in Sustainability (left) and the Next Generation Core Competencies in Emergency Management (right) as well as the structural elements of both frameworks (including their relationships, their similarities (=) and the terminology used in this paper).

sustainability and emergency management and the concept of resilience into a capacity building program for working professionals.

The gap is twofold. Firstly, there is a *conceptual gap* related to comparing and connecting all three fields with each other. So far, efforts have compared select concepts only. For instance, Anderies et al. (2013) [33] compare sustainability, resilience and robustness; Schneider (2013) [29] compares sustainability and emergency management; various scholars compare sustainability and resilience [15,25,62], and Tveiten et al. (2012) [27] relate resilience to emergency management. Secondly, there is a *practice gap*, reflected by the lack of capacity building trainings that integrate the three fields to help city governments further their work in holistically addressing future challenges in a collaborative way. This gap was identified by one of the co-authors, a city practitioner and member of various city networks and professional associations ranging from the local to international level.

Focusing on the practice gap the objective of this research is to appraise a new capacity building program, developed by external entities and implemented by the researchers. This new program purports to integrate sustainability and emergency management competencies and resilience as a concept. The research builds on the premise that both, the use of collaborative competencies and collaborative activities across city departments, is necessary to holistically address urban challenges and reduce disaster risk (see Table 1).

Thus, the overarching question is whether the program effectively develops these competencies and concepts in participants and thereby fosters collaboration across participants of the involved city departments.

To this end, the following two research questions were addressed:

1. Which competencies are developed in participants through the capacity building program?
2. What adjustments to the capacity building program are suggested by participants to increase participant satisfaction, strengthen the learning experience and foster a collaborative approach of city

governments integrating their work the fields of sustainability, emergency management and resilience?

Answering these questions will help make a case for how to foster an integrative and transdisciplinary city government approach by building staff capacity and addressing the elements of 'collaboration through competencies' (question 1) and 'collaboration through activities' (question 2).

## 2. Methods

### 2.1. Project background

The City of Tempe provides a case of a city government aiming to address emergency management, sustainability, and resilience in integrative ways by building its collaborative capacity through competency-based serious games as part of institutional work. This aim has been triggered by the urgency of climate impacts in Tempe, AZ, threatening the livability within the city and inequitably affecting the health and well-being of its residents; harming youth, elderly, as well as members of indigenous communities and people of color the most [63,64]. Tempe shares many urban challenges with other cities in the Western United States, exploring how to equitably address compounding hazards of heat, drought and wildfires while maintaining water and air quality [63, 65].

This research contributes to an ongoing transition process by the City of Tempe towards integrating the city's sustainability, emergency management and resilience efforts. Tempe's transition process started in 2012/2013 through an ongoing partnership with Arizona State University (ASU), reflecting broader contextual developments across cities in the US. These developments occurred as sustainability professionals expanded their focus on measuring carbon reduction in the energy field to working on resilience and disaster risk reduction measures [66–68]. They did so while increasingly incorporating racial equity and social justice work. Examples of these integrated efforts are Portland's 2015

Climate Action Plan and Providence's 2019 Climate Justice Plan [69]. This shift was in part triggered by the [Rockefeller Foundation's 100 Resilient Cities Program](#) allowing cities to hire staff to work on climate change policies and risk reduction measures [70]. The investment also led to the establishment of resilience offices, either as part of the cities' sustainability offices (e.g. [Orlando, FL](#)) or as separate offices (e.g. [Los Angeles, CA](#)). Another driver was the establishment of networks such as the Urban Sustainability Directors Network (USDN) and the International Council on Local Environmental Initiatives (ICLEI). USDN provided guidance on how cities can integrate resilience and sustainability into all hazard mitigation plans. ICLEI facilitated the learning from cities attempting to coordinate their work across the fields of sustainability, resilience and disaster risk reduction [67,68]. As a result, Tempe and many other cities across the US, resolved to address the need for integrating their sustainability, resilience and emergency management work, while coping with the tensions of all three fields.

Tempe's process moved along in phases, marked by these milestones: In 2015, the city established its Sustainability Commission to share best practices and promote city-wide collaborations to inform holistic sustainability solutions to the city's most urgent challenges. In 2016, the city hired a full-time sustainability officer to push sustainability within the city government as part of its strategic plan and to help its departments reach their [sustainability targets](#), including i.e. resilience to extreme heat. To this end, city staff participated in a series of trainings using serious games. The first training "Future Shocks and City Resilience" (November 2016) aimed to integrate sustainability and resilience thinking when planning long-term strategies, allowing inter- and intra-departmental collaboration on sustainability efforts amongst city officials and researchers [48]. The second game "AudaCITY" (August 2017) taught city leadership what sustainability strategies can be taken and how they impact the urban environment and people's lives [57,71]. These capacity building trainings in conjunction with the collaborative work through the ASU partnership also laid internal educational foundations for the city's planning work. In 2017, the city approved its [Urban Forestry Master Plan](#), setting goals for tree and shade management and budget estimates to implement heat mitigation measures. In 2019, the city launched its first [Climate Action Plan](#), which is one of the first to include extreme heat as a hazard and extreme heat mitigation measures (i.e. a green construction code). In 2020, the city hired a full-time Emergency Manager, replacing the part-time model where the position was carried out by the Deputy Fire Chiefs, and exploring how to position this office and function to enhance departmental collaboration [72]. Considering that emergency management and sustainability are efforts that involve each city department, the Emergency Manager and Sustainability Director started working together to coordinate across city departments towards city government and community resilience. The presented research tied into this process.

The Tempe case illustrates the situation of cities across the US and their efforts to reorganize their institutional structures towards integrative and collaborative approaches that address root causes of extreme (heat) events and do so in equitable ways. For instance, Phoenix, AZ is planning to establish a new Office of Heat Response and Mitigation [73] and Los Angeles, CA is planning to establish its first-ever Climate Emergency Mobilization Office (CEMO) [74]. The research presented here ties into this transition process and its institutional work.

## 2.2. Research design and theory of change

The research was conducted as a transdisciplinary case study, evaluating the above-mentioned capacity building program [75,76]. The research team comprised three scholars and three practice partners, including the City of Tempe's Sustainability Director and the Deputy Fire Chiefs. The case study design followed the essential steps, such as a literature review, constructing a theoretical framework and premise [77, 78]. The premise is that fostering collaboration between the three fields (sustainability, emergency management and resilience) in city

governments is needed to allow city staff to overcome silos and to develop integrated approaches to urban challenges.<sup>2</sup> To do so, a capacity building program as an element of institutional work is utilized. The associated theoretical framework, comprising three key elements is described below and visualized in [Fig. 2](#).

Firstly, the capacity building program entails both competencies frameworks: SC and EMC (see section 1.2 and [Fig. 2](#), Nr. 1). This fosters collaboration since participants from different city departments get exposed to and interact with competencies of the two fields and the concept of resilience ('*collaboration through competencies*'). This builds on the research done by Bhagavathula (2020) [56] who analyzed the design of a capacity building program, determining whether the instructions provided for each training intended to foster competencies and which ones. She found that while the instructions for each training referenced elements of both competency sets, EMC and SC, they did so with varying degrees of comprehensiveness and specificity of its elements. On this basis, it was assumed that training participants ought to be able to engage with the general meaning and some more specific elements of each competency set. The pre-surveys elicited participants' understanding of competencies for collaboration and found that participants had some understanding of competencies in terms of their usage in their daily work.

Secondly, the capacity building program entails collaborative silo-crossing activities and approaches in form of serious games (as introduced in the introduction section and in [Fig. 2](#), Nr. 2). This fosters collaboration in two ways: A diverse group of participants interacting with each other triggers elements of collaboration, such as getting to know other staff members and their work or building trust through these activities. This interaction also facilitates exchange of information, increasing content knowledge around location-specific hazards, sustainability and resilience issues (i.e. equity and homelessness). This allows participants to realize how different departments' work intersects on the same topic and how to team-up more effectively ('*collaboration through activities*').

Thirdly, the capacity building program is an element of institutional work, because through the serious games individuals learn how to take actions to maintain, disrupt, and create new rules with regards to managing hazards towards sustainability and resilience (see [Fig. 2](#), Nr. 3). Each serious game draws on the competencies and includes location-specific content knowledge on hazards as well as sustainability and resilience challenges. Additionally, the serious games are combined with reflective activities throughout the program to help participants to explore how to transfer insights from the games into their work settings.

In summary, the program combines a suite of serious games which are based on sustainability, emergency management competencies, resilience as a concept and content knowledge. It aims to foster collaboration by two means: (1) '*collaboration through competencies*' and (2) '*collaboration through activities*'. After the capacity building program, it is assumed that collaboration across the three fields within the local government structures is increased, leading to a more holistic approach to address the complexity of challenges cities are facing.

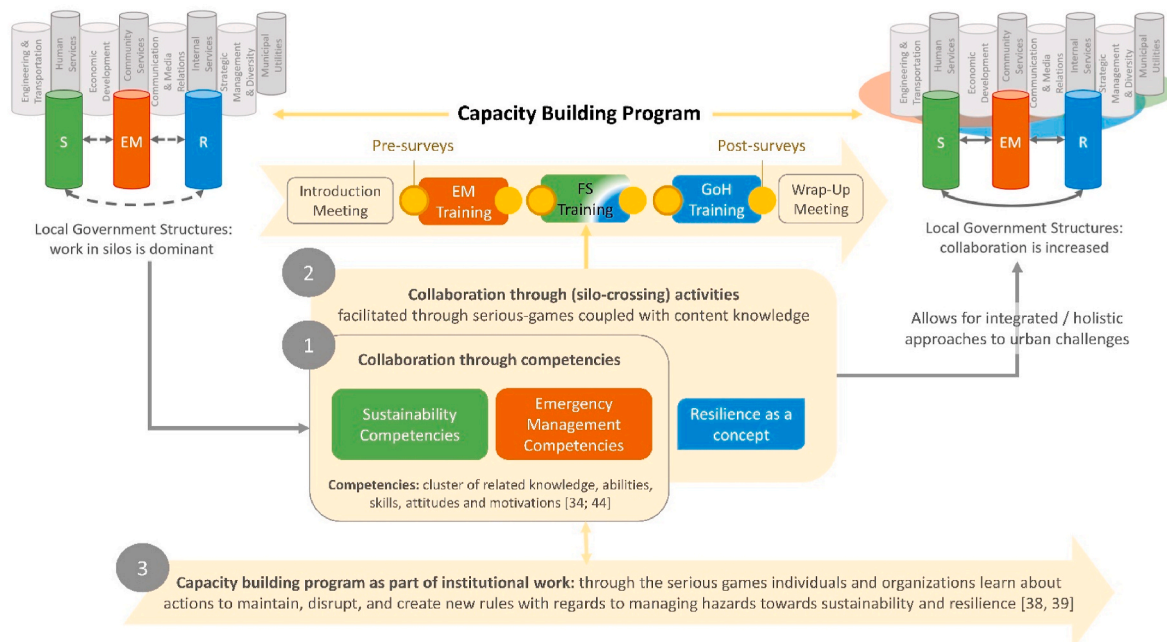
To operationalize the theoretical framework, the intervention research design was drawn on to collect data [79–81]. To design the intervention (the capacity building program) the researchers developed a program that ensures a well-rounded learning experience, avoiding trainings to become a one-off activity. The program was built on three existing trainings, combined into one capacity building program by connecting them with pre- and post-surveys and bookending them with a self-created introductory and a wrap-up meeting respectively (see [Fig. 2](#)). The sequence and structure of the program was intentionally designed in a repetitive way, with pre-survey, training, post-survey and

<sup>2</sup> As indicated in the introduction, overcoming silos starts with a conversation acknowledging their existence and moving on to discussions on how to dismantle them.

**Table 1**  
Overview of selected trainings for the capacity building program.

Name	Emergency Management Training (EM Training)	Future Shocks and City Resilience (FS Training)	Game of Heat (GoH Training)
<b>Topic</b>	Emergency Management	Sustainability and Resilience	Resilience
<b>Aim of training (and content knowledge)</b>	How to act in case of a municipal cybersecurity breach. How to create an emergency operations plan for this emergency.	How to leverage city assets and connections for sustainability, especially in the realm of climate change and future disasters.	How to understand heat as a hazard and support vulnerable communities during extreme heat events. How to appraise budgeting implication of heat mitigation efforts.
<b>SC elements missing in the design</b>	None	None	None
<b>EMC elements missing in the design</b>	Scientific literacy, Geographic literacy, Sociocultural literacy, Community engagement	Abide by professional ethics, Technological literacy, Scientific literacy, Community engagement, Engaging in governance, Civics and leadership	Abide by professional ethics, Technological literacy, Community engagement
<b>Phase(s) of Emergency Management</b>	Preparedness and Response	Preparedness	Mitigation and Response
<b>Number of participants</b>	33	9 <sup>a</sup>	19
<b>Number of departments</b>	15	9	11
<b>Pre-Surveys collected</b>	27	9	17
<b>Post-Surveys collected</b>	29	9	17
<b>Primary training sources</b>	Provided and created by city partners according to FEMA’s HSEEP guidelines by the US Department of Homeland Security (2013) [83]	Keeler et al. (2017) [48]	USDN Innovation Fund (2016) [84]

<sup>a</sup> Close timing to Thanksgiving holiday restricted the availability of participants.



**Fig. 2.** Local government structures before and after institutional work occurred through a capacity building program (incl. three trainings with repeating elements such as pre-post-surveys, and one introductory and one wrap-up meeting). The program entailed serious games that are competency-based (Emergency Management (EM), Future Shocks and City Resilience (FS), Game of Heat (GoH)). Abbreviations: S (Sustainability), EM (Emergency Management), R (Resilience).

semi-structured group discussion. The researchers hereby followed guidance in pertinent literature [43,46,48,82]<sup>3</sup> regarding structure, set-up and elements of the trainings. The program focused on comprehension and application of the competencies from sustainability and

emergency management, and conveyed resilience as a concept as part of the content knowledge, as no stand-alone set of competencies or framework was available. To select trainings supporting these goals, six selection criteria were established: the training (1) is developed for local governments, (2) addresses one or two fields (emergency management, sustainability or resilience), (3) is a multi-player serious game and follows a similar structure, (4) can be integrated into existing training efforts, (5) focuses on the real-world challenges (i.e. heat, floods, dust storm, and equity), and (6) if possible, was partially implemented with Tempe city staff before. Furthermore, while the “Future Shocks and City

<sup>3</sup> Though the paper by Fleming et al. (2020) [47] was not published yet at the time of the intervention in 2019, they propose a similar structure, especially highlighting the importance of a discussion post-training (represented by the “semi-structured group discussion” in this research).

Resilience” training [48] was designed with SC in mind neither trainings were designed with EMC in mind.

Participants were made up of city staff from 9 to 15 different city departments. The three city partners recruited participants. While most participants attended one training due to scheduling conflicts, some attended multiple trainings. Participants’ work dealt with one or more of the three fields of sustainability, emergency management or resilience to ensure the training content and competencies lined up with their work.

Table 1 presents an overview of the selected three trainings.

### 2.3. Data collection

The program was implemented over the course of four months from October 2019 to January 2020. The researchers held the introductory and wrap-up meetings. During the three trainings, the researchers took on an observer role for data collection purposes on participants’ performances and for consistency. 1–2 external facilitators guided 1–2 groups of participants through the trainings, while 1–2 notetakers per table took written notes on discussions and findings. Notetakers and facilitators were trained by the researchers. They participated in preparatory sessions, working through the specifically developed facilitator’s guide for each training, and participated in a dry run where they played the serious games. Facilitators were encouraged to prompt consideration of competencies, especially collaborative ones, during the trainings. These sessions allowed to develop a shared understanding and language as well as to clarify questions. Notetakers and facilitators volunteered their time. At four events audio-recordings in mp3 or mpeg-4 audio files were taken.<sup>4</sup> Field notes were taken from a variety of activities (incl. preparatory sessions, conversations and meetings with staff, job shadowing of the Sustainability Director, impressions while reviewing literature and the data).

Participants completed written, short pre- and post-training surveys for each training. The pre-survey was composed of 15–20 multiple choice and open-ended questions allowing participants to reflect on which competencies are important to their roles in their departments’ processes and daily work. In the post-survey participants self-assessed<sup>5</sup> what they retained from the capacity building trainings and made recommendations on training improvements, regarding the objective of providing an integrated and collaborative approach to sustainability, emergency management and resilience. Anonymized participant quotes are given in the result section to evaluate the trainings’ effectiveness to foster collaboration and develop competencies on the basis of real-world problems throughout the implemented capacity building program.

Each training was followed by a semi-structured group discussion reflecting on the learning experience and learning satisfaction as well as on improvements and lessons learned for using this training to help city staff better achieve their strategic priorities and collaborate across the three fields.

Data analysis, using a codebook, combined a deductive analysis with a subsequent inductive analysis following Ryan and Bernard (2003) [86] and Saldaña (2016) [87].

<sup>4</sup> The research team received approval to use recordings for the research by the ASU Institutional Review Board (IRB) and participants were asked for permission prior to the trainings. IRB also approved the research procedures, including recruitment and consent forms as well as survey instruments. Due to the group settings of the games, participants knew each other and thus full confidentiality among participants could not be provided. Due to the official nature and for security reasons no audio-recordings were made during the EM Training.

<sup>5</sup> Self-assessments are critically discussed in the literature as they have some limitations [85]. Nevertheless for the purpose of this research and the constraints of this research project, especially as most data was collected and assessed through audio-recordings and researchers’ observations, the self-perception is sufficient. Additionally, detailed information on the pre-survey is provided in Bhagavathula (2020) [56].

### 2.4. Limitations of the research design

Although core steps by Fraser and Galinsky (2010) [82] were followed, adjustments had to be made to accommodate budgetary and capacity limitations within the transdisciplinary team. Data collection was limited due to time constraints for the duration of the trainings and survey responses, and due to space constraints making note-taking difficult and audio-recordings inaudible at times. Further limitations revolve around the impact the evaluation may have on participants. Anticipating participants’ potential reactions when providing feedback (e.g., feeling apprehensive or the need to please the researchers), the approaches to providing evaluative feedback were designed accordingly. Each meeting was internally prepared and hosted by the city staff partners in sustainability and emergency management, respectively. They encouraged their colleagues to voice their concerns, leading by example. Researchers, facilitators, and note-takers took a back seat during these discussions and participated as listeners, except for asking clarifying questions. Additionally, anonymity and confidentiality were guaranteed via a consent form ensuring that survey responses were provided anonymously and without identifiable information.<sup>5</sup>

## 3. Results

### 3.1. Sustainability and emergency management competencies developed

#### 3.1.1. Sustainability competencies demonstrated by participants in each training

This section presents how often participants displayed a competency during the trainings as a means to answer the question whether competencies were fostered during the trainings to increase collaboration. Participants demonstrated elements of the five SC multiple times in each training and demonstration increased with each training. SC and their elements demonstrated were values-thinking competency, systems-thinking competency, collaborative competency, futures-thinking competency and strategic competency, with the most elements of competencies demonstrated in the Game of Heat (GoH) Training. In this section, one example from one training per competency is provided to illustrate the results. Table 2 summarizes the results for each of the five SC, showing how often each competency was demonstrated. Direct quotes from participants provide additional contextual information that illustrate participants’ understanding and use of that competency and the linked content knowledge.

The competency most displayed throughout all three trainings was the *values-thinking competency* (197 times). Values-thinking competency was fostered throughout the GoH Training, through activities that actively address administrative structures and processes that would benefit from improved collaboration. Examples are rating the vulnerability of an asset, assessing the impact of a shock on selected assets or planning adaptation strategies to protect assets from shocks. The latter was stated by one participant: “I believe that all neighborhoods should have access to local fresh food, regardless of income level.” This quote illustrates how participants, applying key concepts of values-thinking competency such as justice, fairness, and responsibility in the training, engaged in negotiations about the types of heat mitigation strategies, for whom and at what cost. Even as ethical concepts were not entailed in the design of the game, participants raised those during the training as reflected in this quote: “[...] We have codes of conduct for all of our city staff for our centers as well as parks. You need to be able to adhere to this code [...]”.

The second most displayed competency was *systems-thinking competency* (166 times). The Emergency Management (EM) Training fostered systems-thinking as it asked participants to address a simulated cyber-attack against city infrastructure impacting multiple city services. Reflecting on their systems-thinking ability after the training, one participant concluded: “We could improve [to have] a better understanding of how a cybersecurity attack can affect all operations and

**Table 2**

Key Competencies in Sustainability [44,53] demonstrated and not demonstrated by participants in each training and direct quotes from participants for contextual information that illustrate participants' understanding and use of that competency. n = number of participants.

Trainings	EM Training (n = 33)	FS Training (n = 9)	GoH Training (n = 19)
<b>Competencies</b>	<b>Number of times demonstrated</b>		
<b>Systems-thinking</b>	19	66	81
<b>Example</b>	“We could improve [to have] a better understanding of how a cybersecurity attack can affect all operations and personnel.”	“From a water perspective, it’s also paying attention to what’s happening North of us. [...] If they release [water], we have to let [it] flow, so it doesn’t necessarily have to be happening here for it to have an impact on what’s going on in and around Tempe.”	“There have been two heat waves and brownouts and blackouts, because the electricity demand goes up during those heat events.”
<b>Reasoning: Applies systems concepts, e.g.</b>	Cause-effect structures, cascading effects, inertia, feedback loops		
<b>Not demonstrated elements</b>	Using a systems perspective to test transition strategies, analyzing tipping points and resilience measures across different scales/ domains	Using a systems perspective to test transition strategies	Considering tipping points and resilience measures across different scales/ domains
<b>Futures-thinking</b>	7	52	36
<b>Example</b>	“We are very prepared to respond to emergencies, however our reliance on technology can cause issues if computers go down.”	“You’re pretty much guaranteed to have some power outages. [...] If it’s an extended power outage, people that have mobility problems will have issues getting resupplied with food and medications and things like that. Especially the elderly population.”	“We will definitely experience one more heatwave.”
<b>Reasoning: Applies future concepts, e.g.:</b>	Path-dependency, triggering events	Risk, precaution and intergenerational equity	Anticipation of how sustainability problems might evolve or occur over time (scenarios)
<b>Not demonstrated elements</b>	Considering non-invention scenarios	Exploring non-intervention futures	None
<b>Values-thinking</b>	3	36	158
<b>Example</b>	“It is also important to have conversations about who will replace us in operational [because it will determine how future trainings	“[Another example is] funding and budget limits: more lights or more swing sets in the park? There’s just different things you could do and budget for.”	“I believe that all neighborhoods should have access to local fresh food, regardless of income level.”

**Table 2 (continued)**

Trainings	EM Training (n = 33)	FS Training (n = 9)	GoH Training (n = 19)
<b>Reasoning for classification: Applies values concepts, e.g.:</b>	and collaboration will work.]” Applying normative orientations to future activities and strategy building	Identifying tradeoffs and ‘win-win’ synergies	Clarifying values, e.g. justice, fairness, responsibility
<b>Not demonstrated elements</b>	Considering overall ethical and moral concepts incl. justice, equity, responsibility, fairness	Considering risk, harm and damage	None
<b>Strategic thinking</b>	5	32	50
<b>Example</b>	“Create and update court Continuity of Operations Planning (COOP) plan”	“There’s only so many people in our [...] staff and they only work so many hours. So we came up with the possibility of working with ASU’s phone bank, because they have more [...] resources. If there was a big problem, we could have people call the ASU phone bank, and then share city-wide information.”	“Other factors like funding would be a roadblock.”
<b>Reasoning: Applies strategic concepts e.g.:</b>	Creating and/or have plans and keep them updated	Overcoming systemic inertia, path dependencies and other barriers to reach envisioned outcomes	Considering barriers including obstacles, inertia, path dependencies
<b>Not demonstrated elements</b>	Overcoming systemic inertia, path dependencies and other barriers to reach envisioned outcomes, developing and testing systemic interventions, transition strategies and plans to leverage assets, mobilize resources, and coordinate stakeholders	None	None
<b>Collaborative</b>	28	47	40
<b>Example</b>	“While I see a need for collaboration, I see the city does [already collaborate] too.”	“We work very closely with parks <sup>6</sup> on developing and revitalizing the park system.”	“[The training is good to] learn about priorities and concerns in other departments and to see other perspectives.”
<b>Reasoning: Applies collaborative concepts, e.g.,</b>	Engaging in teamwork and with stakeholders	Successfully collaborating with various stakeholders from government,	Building empathy through perspective taking and immersive experiences

(continued on next page)

Table 2 (continued)

Trainings	EM Training (n = 33)	FS Training (n = 9)	GoH Training (n = 19)
Not demonstrated elements	Building trust, creating non-judgmental interactions, demonstrating and encouraging empathy and cooperation	business and civil society Building trust, creating non-judgmental interactions	Employing various approaches for building trust and creating non-judgmental interactions

personnel.” This quote references pertinent concepts such as cause-effect structures (i.e. “how a cybersecurity attack can affect all operations and personnel”) and closing feedback loops through learning (e.g. “We could improve [by having] a better understanding”). Meanwhile other concepts, including the analysis of tipping points and other resilience measures across spatial scales and domains were not demonstrated, which reflects the training design, as these concepts were not entailed in the training instructions either.

*Collaborative competency* was demonstrated 115 times. The ability of city staff from different departments to collaborate is asserted in this participant’s statement, a staff member from the Engineering and Transportation Department: “We work very closely with parks<sup>6</sup> on developing and revitalizing the park system.” Participants’ performances reflected parts of the training design, as the instructions required participants to articulate their roles, responsibilities and specify joint contributions to sustainability problem-solving and collaboration opportunities. Missing elements from the Future Shocks and City Resilience (FS) Training instructions (e.g. the ability to demonstrate empathy) were nevertheless demonstrated by participants during the training.

*Futures-thinking competency* was demonstrated 95 times. Elements of this competency were not entailed in the EM training instructions. To respond to the cyberattack scenarios, participants were not asked to consider key concepts of futures-thinking including sustainability visions and/or non-invention scenarios, serving as necessary positive/negative future reference points for strategy development. Instead, participants were asked to create a strategy right away including prevention, mitigation, and adaptation responses, demonstrating elements of strategic thinking competency. Although missing in the instructions, participants demonstrated futures-thinking. For example, one participant in the EM Training said: “We are very prepared to respond to emergencies, however our reliance on technology can cause issues if computers go down”. This statement demonstrates abilities to anticipate possible future emergencies, while recognizing key elements of futures-thinking competency such as path-dependencies (e.g. “our reliance on technology can cause issues”) and triggering causes (e.g. “if computers go down”).

*Strategic thinking competency* was demonstrated only 87 times. In the GoH Training, it was fostered through an activity where participants had to implement adaptation measures. The quotes expressed by two participants represents applications of key concepts of strategic thinking, such as identifying barriers (“Other factors like funding would be a roadblock.”) and actions to mitigate problems (“Let’s revise the health and safety requirements for extreme heat events”). Participants addressed all critical elements of this competency during the training, although key concepts were missing in the instructions (e.g., ability to design and carry out plans, interventions and actions to mitigate problems).

<sup>6</sup> City of Tempe’s Parks and Recreation Services (part of the Community Services Department).

### 3.1.2. Emergency management competencies demonstrated by participants in each training

The three categories of the EMC were demonstrated by participants in each training. While collaborative competency was explicitly captured through the competencies ‘leadership’ (1 time) and ‘community engagement’ (12 times) in the category *Competencies that Build Relationships*, participants also demonstrated all other competencies for a holistic approach to collaboration. Table 3 summarizes the results for each of the EMC, showing how often each competency was demonstrated and providing contextual information through quotes illustrating participants’ understanding of that competency and associated content knowledge.

*Competencies that Build the Individual* was the most demonstrated category in all three trainings (208 times). They were fostered through the GoH Training, which guided participants through a simulated extreme heat event, testing their ideas on solutions to adapt assets to such an event. One participant stated: “[The] training is very effective in creating awareness on the different facets of responses to emergencies by building the needs and priorities for proactive and reactive strategies and measures”. This quote references key concepts of the competency ‘possess critical thinking’. It expresses the ability to consider how to achieve the goal of identifying and reducing disaster risk, clarifying potential causes and effects (i.e. training as a means to emergency response by “creating awareness on the different facets of responses to emergencies”).<sup>7</sup> It also indicates participants engaging in continual learning to increase their efficacy (i.e. “Training is very effective in creating awareness”) reflecting ‘continual learning’ competency.

*Competencies that Build the Practitioner* was displayed 115 times. An example is given in this participant’s statement in the FS Training: “With extreme heat, [homelessness] would be a huge issue since [people experiencing homelessness] are one of the most vulnerable populations living outdoors, susceptible [...] to the elements.” This quote reflects ‘sociocultural literacy’ competency by recognizing the social determinants of risk, in this case of heat (i.e. “with extreme heat, [homelessness] would be a huge issue”).

*Competencies that Build Relationships* was the category demonstrated the least throughout the three trainings (90 times). When asked about their ‘disaster risk management’ competency to prepare city structures for a cybersecurity attack, one participant stated: “Office storage of forms for manual processing [and] offsite storage for laptops for limited use [should be implemented] as networks [are] attacked”. This speaks to the ability to apply strategies (i.e. to have “office storage of forms for manual processing” and “offsite storage for laptops for limited use”) to prevent new, reduce existing, and manage residual disaster risk, ultimately contributing to loss reduction.

All competencies regardless of category were reflected in at least one of the trainings. In fact, competencies were demonstrated more often during trainings than they were entailed in the written instructions. The following competencies were reflected in all three trainings and explicated in the training design: Competencies to operate within the EM framework (62 times), possess critical thinking (77 times), continual learning (63 times), systems literacy (59 times) and disaster risk management (72 times). Meanwhile, sociocultural literacy (27 times) and governance and civics (5 times) were demonstrated in each training, while not being entailed in the training instructions.

<sup>7</sup> This example applies critical thinking to strategy development focused on disaster risk reduction. It illustrates how the SC and EMC relate to each other: Critical thinking is defined in the SC framework as a basic academic competency underlying the SC; hence it influences all SC. In the EMC it is considered an individual competency at the core of the nested system as part of the competencies that build the individual.

**Table 3**

Next Generation Core Competencies in Emergency Management [52,55] demonstrated and not demonstrated by participants in each training and direct quotes from participants for contextual information that illustrate participants' understanding and use of that competency. n = number of participants.

Trainings	EM Training (n = 33)	FS Training (n = 9)	GoH Training (n = 19)
<b>Number of times demonstrated</b>			
<b>Category</b>	<b>Competencies that Build the Individual</b>		
Operate within the EM Framework	13	26	23
Possess Critical Thinking	13	14	50
Abide by Professional Ethics	3	3	0
Continual Learning	44	15	4
<b>Example</b>	“Continuous training for employees to make them aware of dangers.”	“[...] We have codes of conduct for all of our city staff of our centers as well as parks. You need to be able to adhere to this code, which are the very general guidelines that talk about the types of activity there are that are appropriate [...]”	“Training is very effective in creating awareness on the different facets of responses to emergencies by building the needs and priorities for proactive and reactive strategies and measures.”
<b>Reasoning</b>	Ability to engage in continual learning as a central means of increasing their efficacy when operating in a dynamic risk environment	Professional ethics delineate expected and appropriate conduct, principles, and moral and ethical values that guide practice in the midst of both known and uncertain environments	Ability to identify and reduce disaster risk in the communities they serve which involves problem-solving, strategic, adaptive, and innovative thinking
<b>Category</b>	<b>Competencies that Build the Practitioner</b>		
Scientific Literacy	1	0	0
Geographic Literacy	0	4	15
Sociocultural Literacy	11	8	8
Technological Literacy	9	0	0
Systems Literacy	10	13	36
<b>Example</b>	“Don't open emails or attachments from unknown senders.”	“With extreme heat, [homelessness] would be a huge issue since [the homeless] are one of the most vulnerable populations living outdoors, susceptible [...] to the elements.”	“There will be a 10% increase in roadway maintenance, budget and labor because of the increased heat.”
<b>Reasoning</b>	Ability to recognize the social determinants of risk, as both the risks for and the effects of disasters are socially produced	Ability to recognize the social determinants of risk, as both the risks for and the effects of disasters are socially produced	Ability to see inter-relationships and patterns of change
<b>Category</b>	<b>Competencies that Build Relationships</b>		

**Table 3 (continued)**

Trainings	EM Training (n = 33)	FS Training (n = 9)	GoH Training (n = 19)
<b>Disaster Risk Management</b>	24	24	24
<b>Community Engagement</b>	0	7	5
<b>Governance and Civics</b>	1	2	2
<b>Leadership</b>	1	0	0
<b>Example</b>	“Office storage of forms for manual processing [and] offsite storage for laptops for limited use [should be implemented] as networks [are] attacked.”	“We have access to a lot of different community groups, including neighborhood associations, especially in the north Tempe area, [...] which we have good relationships with, who would be out there to help us whether that's clean up or just have eyes and ears in the park.”	“[...] Develop a program to prepare transit passengers during heat waves with hydration options such as provision of water bottles or installation of water fountain stations, adding shading and shaded transit stops along with heat health signage.”
<b>Reasoning</b>	Ability to apply strategies and policies to prevent new disaster risk, reduce existing disaster risk, and manage the residual disaster risk, ultimately contributing to loss reduction	Ability to facilitate community ownership of risk which involves an open dialogue and relationship development that fosters working constructively to reduce the shared disaster risk	Ability to apply strategies and policies to prevent new disaster risk, reduce existing disaster risk, and manage the residual disaster risk, ultimately contributing to loss reduction, resilience building, and thriving communities

**3.2. Participant satisfaction and proposed adjustments to strengthen learning for collaboration**

In general, the trainings were seen as useful. Participant satisfaction was high regarding the trainings and the style of serious games as expressed in this comment: “Table-top exercises are a great way to understand strengths and weaknesses”. Comments expressed appreciation for the content, based on real-world problems, such as “This was a really well-done [cybersecurity] scenario that really helped me to understand my role and our capabilities as a city.” Another participant also suggested the trainings help address shortcomings in the city, such as “there is not enough of an understanding of who does what in the organization [and no] strategic way of learning it”.

Participants emphasized that the style of training increased communication, showed inter-connectedness as well as opportunities for breaking down silos and increasing collaboration, supporting the premise of this research. This is expressed through this quote: “I really liked the games. [...] Tempe is very siloed [...], so more of this kind of exercises and sessions of people coming together really helps to break down those silos and [helps us] think about what we can do collectively to better our city.” This was coupled with the perception that game-based trainings were a good conversation starter as they put participants in the right mindset to talk about different topics. Participants also saw the trainings as facilitating a broader, shared understanding of the city's assets.

Participants confirmed the importance of combining several trainings within a capacity building program to allow for deeper learning through continual trainings as illustrated in one participant's statement:

“[You need more than] one training to really start to wrap your head around [discussed subjects]”. Participants recommended to embed trainings deeper into the local government by “spreading it city-wide” across the different departments, recognizing the trainings’ potential to facilitate department-internal engagement. Participants also recommended involving stakeholders outside of city staff, such as businesses and residents, and to support racially and ethnically diverse participant groups. Responses in the pre-training surveys made clear that community engagement was seen as effective in increasing communities’ understanding on “what the risks are, how to mitigate the risks, and then how to respond if it actually happens”, as commented by a participant. The post-training surveys reinforced the notion to explore how to use the trainings to also offer educational opportunities for residents. One participant stated “[We have to make] it clear from the beginning of why we are using a game in order to teach the community how they can respond.”

Against this background, participants identified additional areas that require further discussion.

Participants indicated that trainings for local governments were more beneficial if they were closely related to their work environment and local context (here: City of Tempe) as highlighted by this comment: “It might be easier to comprehend if the game had [more] Tempe details” (speaking about the GoH Training). In addition, trainings ought to address the differences of hazards impacting different areas of the city in various ways, as reflected in this comment: “[...] potentially you’re doing different trainings in different places. Game of Heat might be relevant in some neighborhoods in the city, and [another training] could be used in a different one. There might be various trainings that are geographically dependent too.”

Furthermore, participants highlighted that people have different learning preferences and trainings should cater to diverse learning styles. The game was perceived to cater to a more interactive and communicative learning preference, lacking solitary elements (i.e. self-study), which made this learning mode challenging for some. To support learners with other learning preferences, participants suggested to send out more material prior to trainings allowing participants to prepare (e.g., pre-written learning objectives, purpose and content of training, structure of activity). Another recommendation included to provide participants with optional homework. They also recommended to incorporate an explicit “take-away round” into the de-briefing discussion after the trainings, as illustrated in this participant’s comment: “People are going to have these things that they leave unanswered. And so [...] part of the homework after [the training] is just people going around the room saying ‘what was one thing you realize[d] today that you didn’t know anything about that you’re going to go and try to figure out the answer to’.” In essence, declaring one subject they want to learn more about as a result of the training.

Lastly, participants highlighted that good facilitation was seen as key when it comes to game-based approaches, as it helps with clarifying learning objectives and the game process. Moreover, participants pointed out that good facilitation helps achieve balancing more vocal and less-outspoken participants and avoiding dominance of more vocal persons in the room, which helps the generation of ideas and possible novel solutions.

#### 4. Discussion

The key challenge that this study addresses is that different, often siloed, fields within city governments work on complex urban problems to achieve holistic outcomes. This highlights the need for more collaboration and silo-crossing as a prerequisite for achieving those outcomes. Silo-crossing can be seen as a first step in a two-step process to achieving an integrative city government. Step 1 includes crossing silos by engaging in conversations that raise awareness, acknowledging the existence of silos, and facilitating increased collaboration through activities and competencies. Step 2 then includes activities that help

dismantle silos by integrating the three fields through e.g., joint planning and governmental processes and through interdisciplinary jobs. These new institutional procedures would replace the need for collaborating across different silos. This study addressed the first step of this process, though laying the foundation for the second step. However, by giving city departments the tools to collaborate across silos, this first step can generate the unintended side effect of keeping silos intact, in fact reinforcing them. Thus, it is crucial to continue the process of trainings and conversations around silos to address their dismantling as a next step in future research or by the institution itself.

To help transition from step 1 to step 2 and to increase collaboration within the city government, the results from this research indicate: Overall, collaboration was facilitated in both ways (*‘collaboration through competencies’* and *‘collaboration through activities’*). This can be leveraged, specifically considering three points of discussion: 1) Participants developed some competencies more than others which are key for collaboration and breaking down silos; 2) Fostering collaboration holistically within city governments requires a comprehensive capacity building program; while the proposed program integrates three trainings with their entailed competencies and concepts, it further needs to integrate the two competency sets of emergency management and sustainability with resilience as a concept within each training; 3) Fostering collaboration in practice in the long-term requires treating it as “institutional work” in order to transition from silo-crossing to silo-dismantling, therefore advancing the quality of collaboration.

The first discussion point revolves around the fact that each training supported competency development, albeit to different degrees. The competency demonstrated the most across all three trainings was values-thinking competency. The high relevance participants assigned to values-thinking is promising, because participants’ work within city governments is value-laden, requiring this competency of being able to collectively identify, map, negotiate and reconcile values (c.f. Wiek et al., 2011 [44]). Moreover, sustainability projects and programs are inherently normative and value-oriented [88]. So is emergency management with normative questions of who/what is at risk and who/what receives prevention/recovery funds; explaining why all disasters are considered to be political [29,89,90]. The normative orientation of participants might be reflective of their commitment to their city’s strategic goals and priorities suggesting a shared value system and language among participants. Both are essential elements to creating successful collaboration across departments and with the communities they serve. Moreover, it ties into the push towards more equity considerations in all governmental activities, processes, and plans. Recent findings highlight that values-thinking (of which equity considerations are a central part) underpins every other SC [54], and ought to be centered in present and future, strategic actions. More generally, the ability to assist each other in identifying and meeting shared values/equity considerations, can be facilitated through serious games, as they create a space for communication and deeper understanding [47]. While this result may be Tempe-specific, it is noteworthy that values-thinking competency was the most entailed competency in the training designs. This suggests that implementing this training and emphasizing values-thinking competency in other city context might most likely result in participants’ increased demonstration and use of this competency during the training and in their daily work.

Collaborative competency was demonstrated only 3rd most for SC and least for EMC. In contrast, participants expressed the wish to engage more with community members. To bridge this gap, *‘collaboration through activities’* by bringing people together (e.g. through trainings) needs to be better connected with *‘collaboration through competencies’* by addressing SC (c.f. collaborative competency) and EMC (c.f. leadership and community engagement) alike. The lower relevance participants assigned to collaborative competency might result from the competency not being entailed as much in the training designs, resulting in the competency not being fostered and subsequently not demonstrated by participants. The results show a short-term remedy by

creating favorable conditions for collaboration *during* the trainings. These include e.g. a competency-trained facilitator, who prompts consideration of collaborative competencies and motivates participants to explore related skills. Participants highlighted the importance of a good facilitator in helping them engage during the collaborative activities in the trainings. More importantly, however, is to expressly design trainings with collaborative competencies in mind and explicate them in the training instructions. The low relevance assigned to collaborative competency might also be a result of the selection of participants. While participants reflected a broad range of city departments with different backgrounds, the trainings did not address the hierarchical systems and power dynamics structuring daily work and interactions within and across departments. Addressing these dynamics openly can give rise to new insights and procedures allowing for even better collaboration while increasing the quality of learning for collaborative competencies within an organization. Additionally, it would facilitate the discussion around the existence of silos and the need to cross and eventually dismantle them. Thus, future research on local government capacity building programs should include discussion of hierarchies and power dynamics within the city government in the serious games' design [46] and ought to be reflected in the participant selection.

Additionally, to foster collaboration beyond the city government, participants expressed the wish for more engagement of community members in trainings e.g. through a "mini-exercise" of each training ('*collaboration through activities*' by bringing people together). This in particular would further the inclusion of all community members and social groups, especially marginalized communities, who historically have been omitted in the planning and risk reduction processes [5]. This insight is essential to leverage concepts such as the *Whole Community Approach*. The goal of this approach is to expand the government-centric approach of emergency management by including all those engaged in emergency management to collectively learn about communities' lived experiences through "two-way" interactions of top-down and bottom-up approaches [91]. However, the results also indicate participants' tendency towards the top-down approach, reflecting a known tension of wanting to embrace people-centered approaches to emergency management and sustainability while being socialized in the top-down approach. The trainings could help address this tension. Serious games are suited to simulate situations, in this case for city staff allowing communities to self-organize when needed, while sharing decision-making powers with them [92,93]. Including the proposed mini-exercises involving city staff and community members would allow both to engage in other roles and address the insufficiently explored element of community engagement in serious games [46].

The second discussion point argues that a *comprehensive* capacity building program requires integrating the competency sets from emergency management and sustainability and resilience as a concept. This study explored to what extent the serious games support integrated problem-solving by learning about the competencies developed for sustainability and emergency management professions respectively. The literature review on the competencies sets shows significant overlaps and distinct differences between the sets. This highlights the need to include both competency sets into each of the three trainings in order to develop all competencies needed for collaboration and silo-crossing. Future research should clarify whether resilience remains included as a concept only, or whether there are distinct resilience competencies that are not entailed in the SC nor EMC sets.

The results also showed that combining multiple trainings into one program does foster all competencies, supporting the approach taken in this research. Although multiple trainings are more time consuming for participants, they allow for deeper learning about all competencies, as trainings complement each other while repeating overlapping elements. This way, the program additionally addresses multiple location-specific hazards as well as sustainability and resilience issues (e.g., heat, floods, structural racism, and cybersecurity threats). These real-world problems demonstrate how all three fields are involved, interconnected and how

participants' work connects to them. This creates a space for participants to exchange and collaborate on projects that tackle specific hazards and issues city-wide and across the three fields. Discussing multiple topics (in the form of content knowledge) is beneficial. It facilitates an understanding of how the competency sets can be combined and applied to tackle different challenges and how the three fields overlap and relate to each other in support of sustainability problem-solving and disaster risk reduction for a more integrative local government. The latter is crucial to foster collaboration, because participants demonstrating SC and EMC did so due to a tacit understanding of the situation. Participants likely did not know when, how and why they demonstrated certain competencies. Thus, future research is needed to explore the role of tacit and explicit knowledge in competency development. In addition, future research ought to look at competency development as part of a control group to be able to determine participants' collaboration activities and competencies with and without the trainings.

Besides competency development and '*collaboration through competencies*', the repeated interaction among participants leads to an increased familiarity amongst participants and enhances '*collaboration through activities*', building trust and cohesive teams. Thus, the proposed capacity building program responds to calls arguing that the collaboration among professionals in sustainability, emergency management and resilience requires developing a holistic perspective and the ability to apply concepts and competencies from all three fields [15,25,27,29].

The third discussion point addresses the transition from the first step (silo-crossing) to the second step (silo-dismantling). The results suggest that even a one-time training program, composed of multiple integrated trainings, is not enough to cultivate collaboration across the three fields, governmental hierarchies and with communities. The researchers propose to treat collaboration as an ongoing practice and as "institutional work" [37–39]. This framing emphasizes how a training program can help change the organization's institutions by *maintaining, disrupting or creating* its formal and informal rules and norms. Connecting back to the argument why Tempe is a case for other cities in the US regarding cities' efforts of integrating the three fields (see section 2.1 project background), the trainings helped to improve and change the institution (city government) in all three dimensions.

The trainings helped to *disrupt institutions* by facilitating the building of relationships and clarifying how city staff define their roles in case of a shock. This helps to break down silos by starting conversations about them. Additionally, the trainings further aided city staff who participated in the trainings to include 40 proposed heat mitigation measures in the update of the city's hazard mitigation plan in 2020. The city's plan was also included in the county's all hazard mitigation plan. Elevating heat has a hazard disrupts the traditional approach, especially on the county-level, where heat was previously addressed through short-term measures, such as providing hydration stations, education about heat-related illness and indoor cooling during an extreme heat event [94].

The trainings facilitated *creating institutions* by creating shared knowledge and language about city assets and collaborative approaches to disaster risk and hazard management. This in turn supported the onboarding of the new Emergency Manager and her ability to engage staff in working on city-wide disaster risk strategies (especially on extreme heat) accounting for more community-led approaches.

The trainings raised awareness to which *institutions* to *maintain* in light of the above changes. Participants requested continued training programs, maintaining the 'institution' of on-the-job learning. Participants also expressed a new awareness on the need to maintain and protect nascent institutions, namely the offices of emergency management and sustainability, to allow for meaningful and continued change within the city government.

To increase the training program's contribution to institutional work and embed collaborative activities and competencies deeper in the organization, a few design elements need to be adjusted:

1. Establish clear learning objectives around the three types of institutional change actions and how these changes are meant to foster the resilience of the organization and its institutions when recovering after a major shock [95] as well as aiding collaboration overall.
2. Incorporate a discussion-round with participants prior to trainings around these learning objectives and sending input material to leverage the potential for deeper learning. This aids in maintaining a culture of education and constant communication [43].
3. Have participants reflect more deeply on their experiences while attending the program as a whole and during/after each training with regards to institutional work supporting collaboration and breaking down silos.
4. Include a discussion on hierarchies and power in these reflections by carefully designing interactions that facilitate dialogue between participants across hierarchical levels within local government and participants from different communities.

## 5. Conclusion

This study combined multiple serious games coupled with competencies into one capacity building program for city governments to foster collaboration across the three fields of sustainability, emergency management and resilience. Results indicated participants' engagement with all competencies and concepts (*'collaboration through competencies'*) and highlighted the positive impacts for collaboration by having a diverse group of participants engage with each other throughout the trainings (*'collaboration through activities'*). The trainings helped to lay the foundation for efforts contributing to policy and monetary changes resulting in stronger resilience to extreme heat. Even though the capacity building program did not foster all competencies equally and collaborative elements generated might be short-term if not deliberately institutionalized, it can be seen as a first step to long-term change. This carries implications for other cities.

Firstly, as more positions in city governments are created with an interdisciplinary focus, the importance of an individual having the ability to collaborate (*'collaboration through competencies'*) is highlighted. Simultaneously, the city needs to foster the institutional enablement for collaboration (*'collaboration through activities'*) in order to move from silo-crossing to silo-dismantling and to encourage individuals to use their skills, abilities and knowledge.

Secondly, cities face more extreme heat events. Meanwhile, most of their infrastructures and institutions are not built to withstand nor mitigate long and reoccurring heat events. This work reveals the interest among city staff to focus on heat as a critical hazard, addressing prior neglect in mitigation planning.

All in all, using the City of Tempe as an example, this research appraised the role of an iterative capacity building program for local governments in fostering collaboration and incentivizing the institutional work to create lasting change toward a more resilient and sustainable city equipped for meaningful disaster risk reduction.

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## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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