Design Guidelines for a Gamified Indigenous Knowledge System that Promotes Awareness of Water Resources Issues

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ABSTRACT

Water shortages are becoming increasingly common and promoting awareness thereof has been proposed as a key strategy for empowering citizens with knowledge relevant to water resource issues. A noticeable gap in the literature is the lack of empirical research on indigenous knowledge systems, particularly relating to promoting awareness of water resource issues. Indigenous knowledge that is incorporated in gamified systems is a solution to sustainability that supports urban water resilience. These systems should include gamification design features that are motivating, engaging, and informing and should be integrated in such a way as to produce transformative tools that support urban water resilience. This paper contributes to the body of knowledge by presenting guidelines for designing a gamified indigenous knowledge system that promotes awareness of water resource issues.

Keywords: Awareness, Indigenous Knowledge Systems, Gamification

INTRODUCTION

Water is a vital natural resource for both human and environmental survival and an integral part of social and economic development. The task to improve water management is critical and has become more relevant due to the increase in water resource issues such as shortages (Kunjuzwa, Scholtz and Fashoro, 2020). The problem of water shortages is increasingly reported as a compromising threat to the sustainability of several major cities worldwide (Booysen *et al.*, 2019). South Africa's state of water has been declared a crisis (Gdo, 2018) where millions of South Africans have no access to basic levels of water supply or have very limited levels of access (Rhodes and Mckenzie, 2018). The problem of the water shortage is most noticeable in developing countries that are characterised by water management challenges, rapid population growth, and an increased rate of urbanisation (Enqvist and Ziervogel, 2019). Water resource issues call for a transition towards improved water management, which includes consideration of urban water resilience towards water sustainability (Johannessen and Wamsler, 2017).

Several studies have proposed gamification as a solution to environmental awareness (Börner *et al.*, 2017; and Böckle *et al.*, 2018). However, according to Böckle et al. (2018) connecting gamification to theoretical principles is limited, and the majority of empirical research on gamification is not based on theoretical principles. In addition, existing studies have not investigated indigenous knowledge and the role it plays in gamification for awareness. This paper addresses this gap and presents design guidelines for a gamified knowledge management system, derived from Self-determination Theory (SDT). The proposed guidelines also consider the incorporation of indigenous knowledge for promoting awareness of water resource issues. The structure of this paper is as follows: The research method is described in the next section; this is followed by the literature review, the proposed design guidelines for Gamified Indigenous Knowledge Systems (GIKS). The paper concludes by reflecting on key findings of the review and lessons learnt in the last section.

RESEARCH METHOD

This paper adopted the Critical Literature Review (CLR) as an appropriate method for driving the literature search, which enabled the authors of this paper to gain insights into what has been done by other researchers, and to the current state of knowledge in the field of water management. From this gaps were identified with regard to indigenous knowledge documentation; and studies with systems that use indigenous knowledge to address water resource issues.

LITERATURE REVIEW

The Strive Towards Urban Water Resilience

The City Water Resilience Approach (Fletcher, 2019) defines urban water resilience as "the capacity of the urban water system, including the human, social, political, economic, physical and natural assets, to anticipate and absorb, adapt and respond to, and learn from shocks and stresses to protect public health and wellbeing and the natural environment and minimize economic disruption". City managers are faced with challenges to ensure that citizens have enough and safe drinking water to survive and thrive through sustainable, and resilient urban water systems. The response to the growing demand for water and urban water management shows that there has been a gradual shift from the "control by construction" model to "stewardship and dynamic/adaptive management" for balancing environmental concerns and the economic benefits of water resources development (Petts, Nestler and Kennedy, 2006). From the economic aspect, the significance of urban water resilience should capacitate cities to function in the face of water-related stresses and support the survival of those living and working in the cities (Fletcher, 2019). Furthermore, a water resilient city can survive water resource issues ranging from prolonging drought to floods while exhibiting the capacity to:

- Provide access to high-quality water resources for all citizens.
- Protect citizens from water-related hazards.
- Connect citizens through water-based mobility.

Putting water at the centre of a city's socio-economic development plans can present opportunities for the water sector to develop innovative solutions in addressing urban water resource issues (Jalilov *et al.*, 2017). This approach can improve water practices while promoting awareness of water resource issues, enhancing urban water resilience, improving water management, and sustainable water benefits.

Self-Determination Theory and Gamification

Self Determination Theory (SDT) can be thought of as metatheory in the sense that it comprises several "mini-theories", which are incorporated together to offer a comprehensive understanding of human motivation (Legault, 2019). According to Ryan and Deci (2020), SDT states that people can become self-determined when the following three needs are satisfied:

- Autonomy (the need to feel free and self-directed);
- Competence (the need to feel effective or motivated to overcome the challenge and achieve success) and;
- Relatedness or connection (the need to feel closely connected with others) to prosper and develop.

Alsawaier (2018) states that human motivations, both intrinsic and extrinsic, are often used as the main theoretical constructs in gamification frameworks, as grounded in SDT for promoting motivation and engagement in game-based learning. Intrinsic

motivation refers to "the behaviour that is inherently satisfying or enjoyable", while extrinsic motivation refers to "performance of a behaviour that is depending upon the attainment of an outcome" (Legault, 2019). Gamification is the use of game elements and playing in a non-game context (Deterding, 2011). Gamification has been shown to promote learning (Maharjan and Maharjan, 2017), which can be harnessed to social knowledge sharing and the promotion of societal awareness sustainability issues (such as water) (Castelletti *et al.*, 2019). Gamification has also been shown to incorporate intrinsic and extrinsic motivation techniques to play a key role in achieving natural resource sustainability. Gamification has been widely adopted since its inception, receiving strong attention from academic scholars, researchers, and practitioners. Deterding *et al.* (2011) SDT has also been used as a successful theory for the motivational psychology of video games. Playing video games for "fun" or "entertainment" is the prototypical example of a purposeful, intrinsically motivating activity, and SDT is arguably the most empirically well researched psychological theory of motivation (intrinsic and extrinsic).

To tackle the challenge of solving water resource issues, it is believed that SDT can be used as a lens to understand human psychology towards these issues by investigating these three basic psychological needs for capacitating human development and improving a person's self-determination to overcome water shortages and their intrinsic and extrinsic motivations for participating in sustainable water conservation and engagement in water resource issues. These constructs are illustrated in Figure 1.

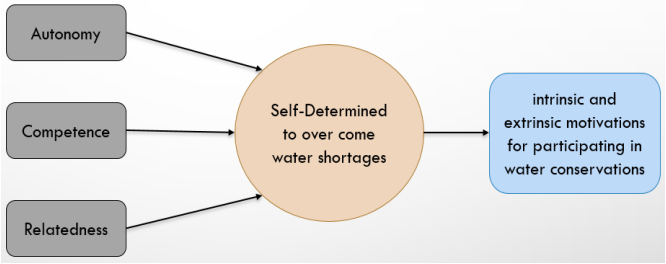

Figure 1: Self-Determination Theory for Water Shortages

According to Kapp (2012) gamification is "using game-based mechanics, aesthetics, and game thinking to engage, motivation action, promote learning and solve problems". Gamification provides features of an interactive system, which aims to motivate and engage users through the use of game design elements (Deterding, 2011), such as those proposed by Kiryakova, Angelova and Yordanova (2018):

- Player(s) – all the participants (students, teachers, and/or citizens) that play the games.
- Challenges – tasks the player has to win to progress to the objective of the game.
- Levels – these are the stages of the game which may range from easy to difficult.
- Points – collected and accumulated through the progressive winning of challenges.

- Badges – these serve as a reward to the player for completed stages.
- Leaderboard – ranking of players based on their achievements, which motivates them to become game leaders.

Knowledge Management Systems and Indigenous Knowledge

Knowledge management is defined by Igbinovia and Ikenwe (2018) as a process of identifying capturing, leveraging, sharing, and effective utilisation of an organisation's assets to enhance its performance. The authors further state that knowledge management systems have been an electromotive force for social, economic, and educational advancement for competitive advantage. Knowledge sharing and information exchange within the field of Integrated Water Resource Management, can be improved with an understanding of cultural considerations, technical opportunities, and the theory underpinning knowledge management (Delfau, 2018). Furthermore, knowledge within the field of water resource management is normally built through practice and is highly linked with contextual factors and personal experience. At the center of knowledge management systems for water resources, people can access information using technologies that support knowledge management for their needs. This approach can present an opportunity to enhance the capacity of human knowledge and contribute towards sustainable water resource management. For an effective knowledge system for managing water as a resource, citizenry cooperation is necessary and should be built on a willingness to engage in water resource issues, and on local and traditional/indigenous knowledge that is trustworthy and truthful.

Indigenous knowledge is defined by Johnson and Johnson (1992) as “a body of knowledge built up by a group of people through generations of living in close contact with nature”. Historically, indigenous knowledge was transmitted by word-of-mouth from one generation to another and is the fundamental component of indigenous knowledge systems (IKS), which have existed for centuries in Africa (Olokesusi, 2004). However, the colonial past has suppressed the growth and further development of IKSs and the capacity of Africans to solve their problem using locally developed technologies. Indigenous knowledge has the potential to unleash the power of cultural diversity, which can contribute to knowledge (indigenous or local knowledge) exchange by citizens. This study therefore recognises indigenous knowledge related to water resource issues that is relevant to all citizens as a key component of our proposed design guidelines for gamified IKSs.

GAMIFIED INDIGENOUS KNOWLEDGE SYSTEM

In this section we present how indigenous knowledge can be incorporated within gamification to promote awareness of water resource issues. The guidelines for a Gamified IKS (GIKS) are summarised in Table 1. Motivation is a fundamental component in the proposed guidelines that aims at triggering the desired human

attitude towards water resource issues. Gamification enables a purposeful integration with game elements to bring out competitiveness amongst citizens on water usage and conservation, while enhancing urban water resilience.

Table 1: Design Guidelines for a Gamified Indigenous Knowledge System (GIKS)

Access to amenities	**Access to amenities**	**References**
Autonomy	The system must be designed to allow the user to feel free and self-directed.	Ryan and Deci (2000)
Competence	The system must allow the user to feel effective and motivated to overcome the challenge while promoting competitiveness.	Ryan and Deci (2000)
Relatedness	The system must provide the user with a sense of connection and relatedness with others.	Ryan and Deci (2000)
Intrinsic motivation	The system must satisfy the user with the highest degree of interest and enjoyment.	Legault (2019); Ryan and Deci (2000)
Extrinsic motivation	The system must allow self-control and awareness to avoid undesirable consequences.	Legault (2019) ; Ryan and Deci (2000)
Gamification elements and features	The system must include design elements of players, challenges, levels, and leaderboards and reward users with points or badges for any activity achieved.	Deterding, (2011); Kiryakova, Angelova and Yordanova, (2018)
Indigenous Knowledge	The system must allow users to share their indigenous knowledge relevant to water, such as conservation practices.	Kunjuzwa, Scholtz and Fashoro, (2020)

The proposed guidelines respond to the lack of theoretical underpinning of gamification research, by using SDT as a theoretical foundation for the design of a gamified IKS (GIKS). The GIKS should encourage best practices in water usage and management at the household level, and the sharing of relevant water knowledge, including indigenous knowledge. These guidelines can be adopted by other researchers when designing gamification-based, knowledge management systems.

CONCLUSION

While the topic of water management and sustainability is globally discussed, the role of gamification and incorporating indigenous knowledge within such technologies for promoting awareness of water resource issues is under-researched. There is a lack of empirical research on incorporating indigenous knowledge with modern technologies for enhancing the sustainability of natural resources such as water. This

situation provides a significant research opportunity for exploration by sustainability researchers to conduct investigations into the effective role for designing an IKS that promotes awareness of water resource issues. This paper presented design guidelines for a gamified IKS for water management. We have successfully identified gamification as an appropriate technology, which triggers human behavioural change with motivating, engaging, and informing capabilities.

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