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THE EXISTENCE OF MEANINGFUL GAMIFICATION ELEMENTS FOSTERING ECOTOURISM BEHAVIOR: GLOBAL TRENDS IN A BIBLIOMETRIC

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ABSTRACT

This study uses a comprehensive bibliometric analysis to look for patterns all across the world to see if there are any unique gamification components in eco-tourism and, if so, what impact they have. With the rise of sustainable tourism practices, gamification elements integrated into eco-tourism experiences have the potential to encourage positive behavioral change and boost visitor engagement. In order to discover important themes, notable works, and global trends in the intersection of gamification and eco-tourism, the bibliometric study systematically examines relevant literature. In order to promote environmental awareness, conservation initiatives, and responsible tourist behavior, this study aims to identify where the meaningful gamification strategies in eco-tourism and assess their effectiveness. Additionally, to better understand and direct future research, the analysis offers helpful insights into the evolving eco-tourism. It is possible to use these results as a springboard for more innovative and participatory approaches to sustainable tourist promotion on a global scale.

Keywords: Ecotourism, meaningful gamification, sustainability, ecotourism behavior, bibliometric analysis

INTRODUCTION

For the purpose of engaging and motivating individuals, gamification refers to the application of game design features, principles, and techniques in environments that are not intended for gaming. The

objective is to incorporate aspects that are commonly seen in games in order to make activities or processes more pleasant, participatory, and rewarding. The usage of gamification can be seen in a variety of disciplines, such as education, business, marketing, healthcare, and even tourism and ecotourism (Christopoulos & Mystakidis, 2023; Damaševičius et al., 2023; Gheitasi et al., 2023; Li et al., 2021; Luo, 2021; Milanesi et al., 2023; Pradhan et al., 2023). Gamification has become an integral aspect of people's lifestyle, particularly in the pursuit of various life objectives such as weight management, body weight control, and daily eating habits. Most importantly when it comes to increasing user engagement, improving learning outcomes, boosting productivity, and encouraging positive behavior, gamification is frequently used as a method. The goal of gamification is to make work more pleasant by utilizing the psychological characteristics of incentive and reward. This, in turn, is intended to encourage higher engagement and commitment from individuals. While the concept was first conceived for the gaming sector it has since found its way, into industries, as a versatile tool to enhance user experiences and achieve specific objectives.

This study aims to explore the integration of gamification into promoting practices within the realm of ecotourism. Encouraging behavior, in ecotourism is vital for ensuring sustainable tourism, where the focus lies on preserving and enriching the environment while providing visitors with educational opportunities. Engaging in practices in ecotourism entails adopting measures that minimize detrimental effects on nature contribute to safeguarding natural and cultural assets and bolster the welfare of local communities. Recent studies have delved into understanding what drives behavior how emotional connections to a place can foster pro environmental actions and the influence of ecotourism experiences on tourists environmental perspectives and intentions (Huang et al., 2023; Jin et al., 2020; Kim et al., 2023; Sun et al., 2021). Research indicates that participating in ecotourism activities can heighten tourists environmental consciousness and encourage behaviors. This effect is particularly significant when tourists are involved in initiatives that underscore the significance of conservation efforts and sustainability. Furthermore sustainable ecotourism now encompasses an equilibrium, among protection, cultural preservation and economic viability—a principle regarded as the primary objective of ecotourism (Huang et al., 2023).

The recent research also indicates that various individuals involved in ecotourism, such, as tourists, local communities and governments play a role in the sustainable progress of ecotourism destinations. Collaboration among these parties is crucial for attaining the goals of ecotourism which involve safeguarding environments improving the well-being of residents and offering enriching experiences for visitors (Šaparnienė et al., 2022). Acting responsibly towards the environment in ecotourism encompasses a set of activities and methods aimed at ensuring the long term viability of tourism practices. Recent studies underscore the significance of education cooperation among stakeholders and embracing an approach, to ecotourism that considers cultural and economic aspects (Jeong et al., 2021).

This research explores how gamification can enhance experiences in ecotourism. The study involves a bibliometric analysis helps to consolidate and synthesize the existing knowledge on the topic, trends, gaps simultaneously provides insights into the publication patterns, influential works, and key contributors in the field and the development of a future research agenda of meaningful gamification. Additionally, the authors propose a future research agenda, outlining areas that require further exploration and investigation. This could include emerging trends, potential challenges, and innovative approaches within the gamification and promising behavior intention domain for youths.

RELATED WORKS

Gamification vs Meaningful Gamification

Gamification is the application of game-design elements and principles in non-game contexts. It is commonly used in e-learning, medical education, and corporate training to enhance engagement and learning outcomes. The concept of "meaningful gamification" emphasizes the use of game elements to create meaningful and sustainable impact, rather than just for the sake of entertainment or engagement. The distinction between gamification and meaningful gamification lies in the intention and impact of integrating game elements. Meaningful gamification seeks to create long-term, positive effects such as enhanced learning, the intention behind integrating game components, motivation, and behavior change, as opposed to simply using game elements for the influence on individual's engagement. While the search results provide insights into the growing adoption of gamification across various sectors, they do not explicitly compare gamification with meaningful gamification. However, based on the understanding of the two concepts, it is evident that the shift towards meaningful gamification reflects a deeper consideration of the purpose and outcomes of integrating game elements in non-game contexts. This shift is aligned with the goal of creating lasting and significant value through gamification initiatives.

Gamification in ecotourism involves incorporating game design elements into tourist activities to enhance visitor engagement and enjoyment. It can include elements like rewards, missions, and quizzes, which can lead to higher levels of knowledge gain and loyalty toward cultural heritage sites (Lee, 2019). Meaningful gamification, on the other hand, emphasizes creating experiences that have intrinsic value to the participant beyond just points and rewards. It focuses on fostering autonomy, competence, and relatedness, which are key to intrinsic motivation according to Self-Determination Theory (Lee, 2019). In the context of ecotourism, meaningful gamification could involve activities that not only entertain but also educate tourists about environmental sustainability and cultural heritage, potentially leading to more sustainable behavior (Slavec et al., 2021). This approach can enhance the visitor's experience by providing a deeper connection to the location and its significance, rather than just offering superficial game-like interactions.

For references on this topic from 2020 to 2024, studies have shown that gamification can positively affect civic engagement and the efficacy of applications designed for such purposes, suggesting that similar approaches could be beneficial in ecotourism (Romano et al., 2022). Additionally, research indicates that gamification mechanisms are positively evaluated by users, particularly when they allow for interaction and competition with others, as well as progression through increasingly challenging missions (Romano et al., 2022). However, it is important to note that the long-term effects of gamification on engagement in ecotourism contexts require further study (Romano et al., 2022).

Meaningful gamification for behavioral change

Meaningful gamification in the context of behavioral change refers to the strategic incorporation of game design elements into non-game environments to motivate and engage individuals, ultimately influencing their behavior in a positive manner. The application of gamification has been explored across various domains, including education, health, marketing, and civic participation. In the field of

education, gamification has been shown to increase student engagement and motivation, leading to improved academic performance (Ghai & Tandon, 2023). The use of game elements such as points, badges, and leaderboards can create a sense of achievement and progression, fostering intrinsic motivation among learners (Dichev et al., 2014). Moreover, gamification can enhance the learning experience by making it more enjoyable and interactive.

In the health sector, gamification strategies have been employed to promote physical activity and healthy behaviors. The use of mobile applications with gamified elements can encourage users to engage in healthier lifestyles by providing immediate feedback and rewards (Cheng & Ebrahimi, 2023). However, it is important to tailor gamification approaches to individual needs and preferences to optimize engagement and avoid potential issues such as over-engagement (Cheng & Ebrahimi, 2023).

Gamification has also been applied in marketing to enhance customer engagement and loyalty. By incorporating game mechanics into retail experiences, businesses can influence customer behavior, leading to increased brand engagement and sustainable behavior outcomes (Sheetal et al., 2023). The satisfaction derived from hedonic value, such as fun and enjoyment, can provide better continued engagement compared to extrinsic rewards (Alzahrani & Alhalafawy, 2023).

In civic participation, gamification has been explored as a means to foster community involvement and engagement in social issues. Although the effectiveness of gamification in promoting civic participation is still under investigation, it has the potential to motivate individuals to contribute to their communities by making participation more rewarding and enjoyable (Romano et al., 2022). Overall, meaningful gamification for behavioral change leverages the motivational power of games to create engaging and motivating experiences that can lead to positive behavior changes across various domains. It is essential to design gamification systems that are aligned with the goals and preferences of the target audience to ensure their effectiveness (Shpakova et al., 2020).

Transforming meaningful gamification experiences into behavioral change in ecotourism involves leveraging the principles of game design to engage tourists in sustainable practices. This approach can enhance environmental education and foster a deeper connection with nature, leading to more responsible behavior among tourists. Recent studies suggest that creating memorable and emotionally engaging ecotourism experiences can significantly influence tourist satisfaction and promote environmentally responsible behavior (Quynh et al., 2021). Additionally, the segmentation of ecotourism motivations can inform the development of targeted strategies that cater to different tourist segments, potentially leading to improved satisfaction and repeat visits (Carvache-Franco et al., 2021).

For the latest references on this topic, the following papers from 2022 and 2023 provide insights into the role of emotional experiences and destination image in ecotourism satisfaction (Quynh et al., 2021), the impact of motivations on the segmentation of ecotourism destinations (Carvache et al., 2021; Kim, 2023). Additionally, research on the healing dimensions of cultural tourism experiences suggests that transformative tourism experiences can lead to improved well-being, which may also apply to ecotourism (Jelinčić & Matečić, 2021)

Meaningful Gamification Elements

In the event to develop strategies for meaningful gamification, Nicholson (2012) explained that for the development of meaningful gamification strategies, concepts relating to play and participatory

museums need to be explored and major elements arising from such exploration were the fact that by definition, play is optional. If the concept of play is included, then the user has to have a choice in system engagement. The information required for decision-making when it comes to the system needs to be provided to the users – this calls to fore the concept of facilitating a ludic learning environment (one that is similar to a science museum). The gamification space should be built as a three dimensional real-world environment rather than one that is a linear system with rewards – the gamified world can be designed to be explorative.

Finally, the recipe for meaningful gamification, according to Nicholson (2012; 2015) is to operationalize the concepts to integrate six elements inspired by game design. The six elements along with their applications to gamification, with examples, are briefly discussed in the next sub-sections.

Play
Essentially play is described as bringing about the freedom to explore, to try out things and to fail without limitations. Such a flexible space changes on the basis of the interest of the learner and is not confined by pre-determined conditions. This playful space provides control to the learners over their learning process and enables decision-making as to the learning ways they want to adopt. According to Nicholson (2015), the creation of such space would allow learners to interact and engage without external rewards as they can have fun and enjoyment within it.

Exposition
Exposition is described as the creation of stories within which real-world environment is integrated to allow the participants to tailor-make their own. However, Nicholson warned against the use of narratives within fantasies as the learner will be placed out of the real world and would be challenging to connect to learning and task goals that calls for skills acquisition, knowledge gain and competencies development in real life scenarios. The self-determination theory (Ryan et al., 2019) is used to give the learner autonomy over the pursued goals and challenges and the story line behind the learning.

Choice
The development of systems that places the authority in the user's hands is referred to as choice and based on the self-determination theory, the importance of choice lies in its provision of autonomy over the environment to the users. Choice in gamification refers to the control placed on the user's hands over the outcome of their learning while guiding their way to achieve the goal. External rewards like badges and points are provided as signposts guiding the way.

Information
In gamification information is the use of game design and display concepts to enable users to learn about the actual world – through the emphasis on this premise, this gamification approach shifts from behaviorism to reward, which is a humanistic approach to relay to the users the basis of such reward and how it can lead them to master learning. Various ways can be used to relay information and in an informative graphic picture, the user can obtain real time information concerning his progress or such progress can be related with the exposition layer that links to actual world scenarios

Engagement
This element of meaningful gamification refers to boosting the discovery and learning of the user through interaction with others who are interested in the actual real-world environment. The gamificaiton system can increase or vary the difficulty level to prevent boredom, while the learner's engagement can be improved using a solo or group-based collaborative or competitive interactions.

Reflection

Reflection is supporting the user's quest to determine interests and prior experiences that can make for a deeper engagement and learning. According to Nicholson (2015), reflection has three major components, namely description, analysis and application. In reflection, learners can scrutinize the activity and share their thoughts with other users through their description, after which the connections to their lives are analyzed and apply them to a different case (description-analysis-application respectively).

Ecotourism

Origins and Definition

The ecotourism concept stemmed from ecological development and sustainable growth that can be traced back to the late 1970s and early 1980s era and ever since its inception it has garnered increasing focus and discussion. The attention may be attributed to its enticing contrast to the mass tourism framework, which has influenced and transformed the social and environmental landscape of the tourism sites all over the globe. Ecotourism, based on Bricker (2017) refers to the sustainable visitation to sites that protect the environment and contribute to the locals' satisfaction and welfare, while providing teaching informative knowledge. Based on the International Ecotourism Society, ecotourism is a sustainable visit to beautiful sites protecting the ecosystem and enhancing the locals' health and happiness (Das & Chatterjee, 2015). Venkatesh and Gouda (2017) mentioned that the general themes relating to ecotourism development, particularly in the developing nations are the reduction of poverty, growth of the economy, development of the community and conservation of nature and culture. Ecotourism relationship and positive effects on the local community happens to be the fastest growing tourism type (Eshun et al., 2016; Hugo & Nyaupane, 2016).

More specifically, ecotourism is an idea that was introduced in 1985 to prevent the mass exodus of visitors during the economic developing in the 1950s, which led to the deterioration of the environment (Sharpley, 2006; Chandran et al., 2023). Consequently, the nation worked towards restoring ownership of the environments to the local people living around them, particularly around the rich natural resources (Sharpley, 2006; Chandran et al., 2023) for the protection of the ecosystems. Ecotourism was also described as responsible travel to natural areas of environmental conservation, sustainability of the local people's well-being as well as those of their communities (Bricker, 2017). Ecotourism is therefore a sustainable tourism type built on the components of culture and nature (Cater & Cater, 2015). It is linked to sustainable tourism and as such, works towards sustainability development success (Cater & Cater, 2015). Nevertheless, sustainable tourism attempts to protect the environment, which culminates in the improved well-being of the locals and enhanced tourism industry profitability (Cater & Cater, 2015).

Environmental concern and engagement

Gamification has shown promise in promoting ecotourism behavior and environmental awareness. Recent research from 2021 to 2024 suggests that incorporating game-like elements, mobile applications, and virtual rewards can effectively engage individuals in sustainable tourism practices and foster a sense of environmental responsibility (Gautam, 2022). Studies have highlighted the importance of incorporating educational content and feedback mechanisms within the gamification approach to influence pro-environmental attitudes and behaviors (Khan, 2022). For instance, a 2023 study found

that gamification techniques were effective in enhancing students' learning skills in science education, particularly in areas such as environmental protection and energy efficiency (Alahmari, 2023). Furthermore, research from 2022 suggests that the COVID-19 pandemic has presented an opportunity for the development of green practices, including the use of gamification to promote sustainable tourism and environmental awareness (Khan, 2022). As the field of gamification continues to evolve, researchers are exploring new applications, such as the integration of artificial intelligence, to better understand and engage end-users in pro-environmental behaviors (Behl, 2021).

Materials and Methods

A technique grounded in bibliometric review was utilized in this study that aimed to examine the potential of meaningful gamification in the tourism industry and its impact on intention behavioral change. We were able to determine the most important contributions to ecotourism and sustainable gamification using this method, particularly in the area of behavioral change intentions, where new dynamics and difficulties surfaced. Consolidating sources of information is one of the many complicated processes involved in a literature review.

First, the database was searched for relevant publications in gamification in general, then specifically in the subject matter of meaningful gamification in ecotourism. Next, we outlined the key features of the general term of gamification literature by looking at factors including annual paper count, study focus, number of citations, and publications years. The next step was to use the existing bibliometric methods to identify the authors, institutions, countries/regions, and their collaborations that had a substantial impact on different parts of the research area. Also included are the most recent developments in the field's research frontiers, as well as present and potential future trends.

Analysis Tools <u>*Preparation*</u>

Several applications need to be prepared in order to undertake data analysis using VOSViewer. We started by making use of the Mapping tool, which is available in the free and open-source VOSviewer application (Figure 1). As a tool for visualizing the analyzed data to be mapped, VOSviewer is utilized in this paper. An application to handle references is the second tool that needs to be set up. Publish or Perish (Figure 2), a reference manager application was used. In order to conduct bibliometric analyses with VOSviewer, this reference manager programme is utilized to gather research data.
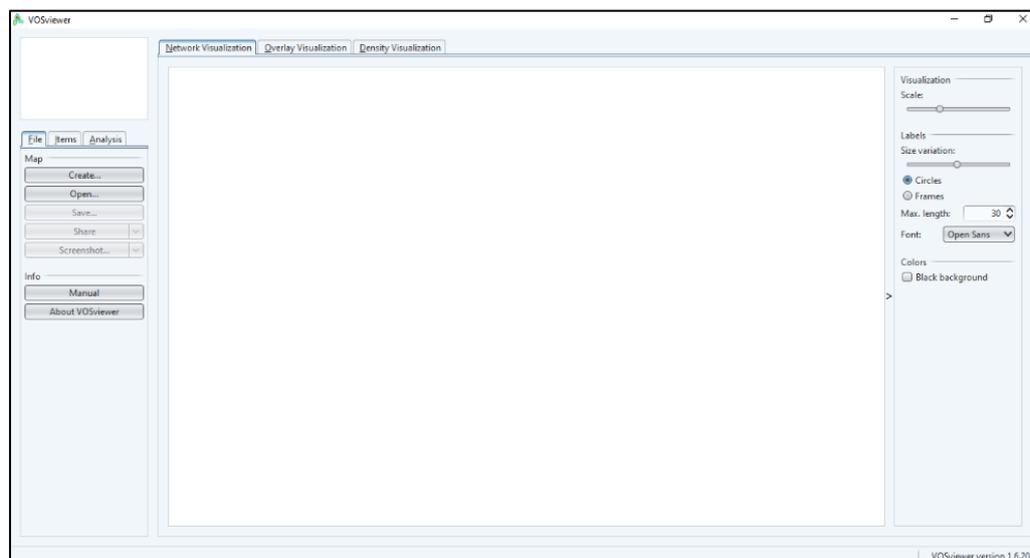
Figure 1
VOSviewer application
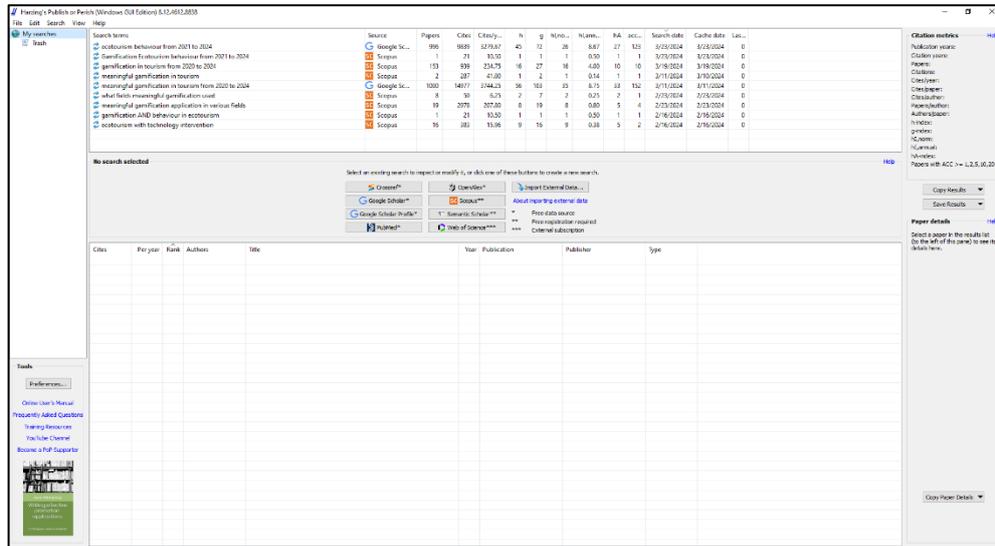
Figure 2
Publish or Perish application

Research data mapping

To begin the data mapping process, we first need to identify the sources of data and the specific data elements that are being used. In pursuit of this goal, we turned to the scholarly databases Scopus and Google Scholar (Figure 3) for data retrieval, which are renowned for compiling a diverse range of high-quality papers from across the globe. Once the sources and data elements are identified, we can then start to map out the flow of data as it moves through various processes and systems. By leveraging the features of Publish or Perish, researchers can ensure the accuracy and thoroughness of meaningful gamification data mapping process, ultimately contributing to the ecotourism integrity and security of the data being used for research purposes.
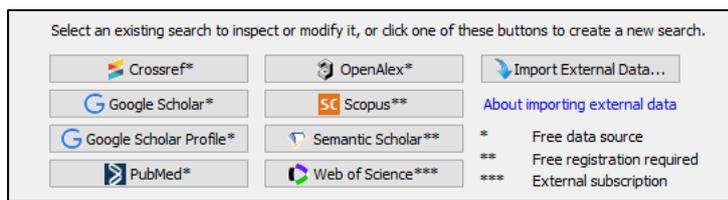
Figure 3
Search data selection on Publish or Perish.

RESULTS

This section discusses how data was mapping. We divided three sections whereby the first mapping was looking at the general terminology of gamification in tourism, meaningful gamification in tourism and meaningful gamification in ecotourism.

Meaningful Gamification

Data mapping started with the articles found in Google Search. We have received 999 articles, the number of citation is 25057, the number of citations per year is 6264.25, the number of citations per

article is 25.08, the author of each article is 2.77, the h-index is 72, the g-index is 125, h1, the annual is 10.50, and the h-index is 39. Based on Figure 4, the network visualization has listed 72 items with six clusters, 813 link and with total link strength is 1459 towards the items.
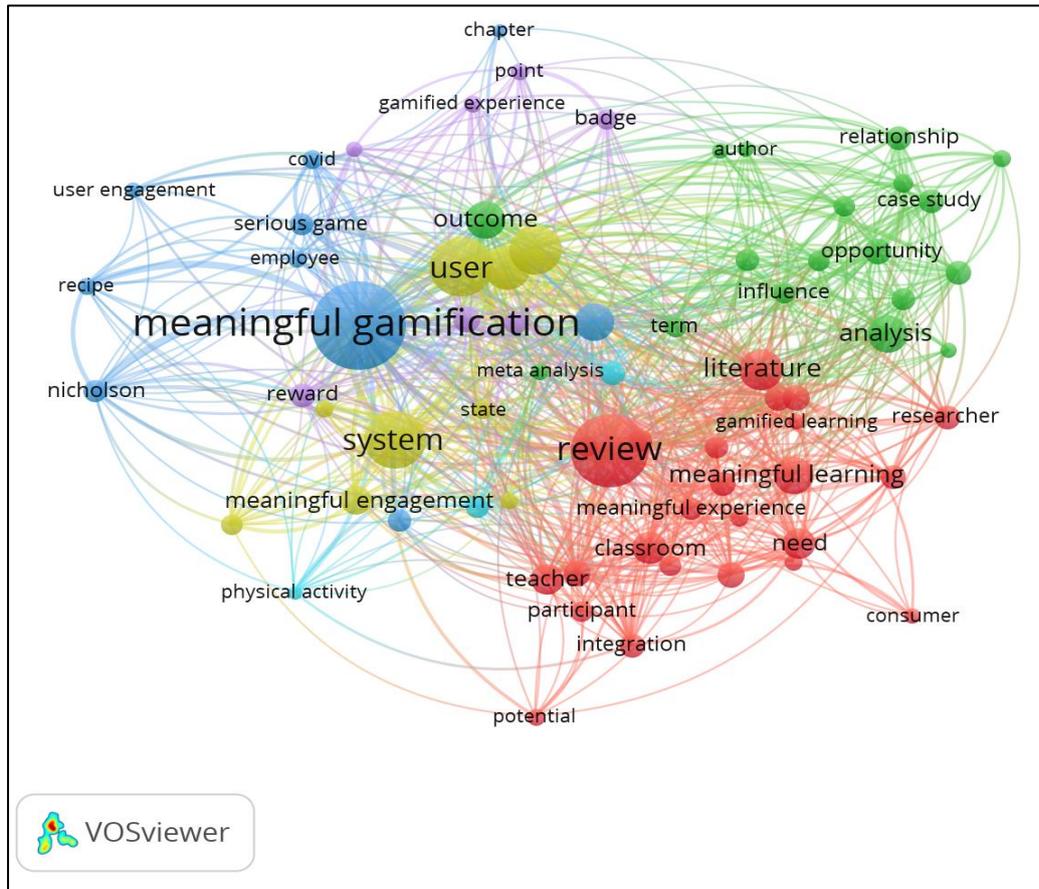
Figure 4
Mapping result of meaningful gamification in 2020-2024

Network Visualization Map on Meaningful Gamification

As can be seen, the findings from on Google Scholar database visualizing the co-word map network of research breakthroughs on digital learning media are categorized into six clusters:

Cluster 1. The red color consists of 25 items including addition, article, aspect, benefit, classroom. Consumer, English, factor, fun, game element, gamification technique, gamification tool, gamified learning, integration, literature, meaningful experience, meaningful learning, need, order, participant, perception, potential, researcher, review, teacher.

Cluster 2. The green color consists of 18 items including analysis, attention, author, case study, child, e-learning, evaluation, evidence, gamification approach, gamification research, influence, meta analysis, opportunity, outcome, relationship, systematic literature review, term and way.

Cluster 3. The blue color consists of 10 items including chapter, covid, employee, meaningful gamification, meaningful way, nicholson, recipe, serious game, technology and user engagement.

Cluster 4. The yellow color consists of 9 items including case, example, framework, gamification design, gamified system, meaningful engagement, state, system and user.

Cluster 5. The purple color consists of 7 items including badge, gamified experience, level, player, point, reward and type.

Cluster 6. The turquoise color consists of 3 items including intrinsic motivation, physical activity and play.

With the clusters above, it can be interpreted that most widely used is not for tourism. Even though the mapping was in cyber era of 2020 year, yet the usage was idle for tourism. As depicts in Figure 3/5, it obviously seen that in the overlay data visualization meaningful gamification has relationship in the education. The darker colors (purple) shown, the cluster and items were back then in 2020 year. By adding element like badges, gamified systems can enhance the meaningful way by making activities more engaging and encouraging teamwork (Alzahrani & Alhalafawy, 2023). Nevertheless, gamification's efficacy can be affected by the novelty effect, which occurs when the initial thrill wears off and leads to less involvement.
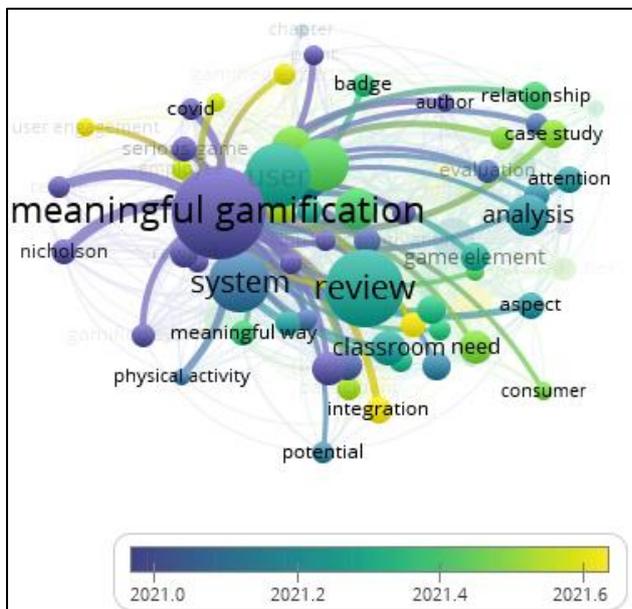
Figure 5
Overlay visualization of meaningful gamification in early year of 2020

However, as the years increasing the pattern has exposed a slight changes which in a lighter color (yellow) of the overlay data depicted in Figure 5. It is suggested that meaningful gamification undergo iterative design upgrades with an emphasis on intrinsic motivation and the incorporation of game-like features beyond monetary incentives in order to maintain engagement. Despite its potential benefits, gamification should only be applied after thorough analysis of the context and target audience. It should not be used blindly in all learning situations (Taskin, 2020).

Figure 6
Overlay visualization of meaningful gamification in 2020-2024

Given these points the later towards the current year 2024 gamification elements game (Figure 6) has correlation meaningful experience with meaningful learning which has relationship with the output. Game application elements encompass various aspects, including challenges, badges, points, storytelling, etc. These mechanics are employed to enhance engagement and motivation within the gamified experience. Given their influence on students' behavior, engagement, and motivation, it is crucial to recognize, select, and apply game elements within gamification (Zourmpakis, 2023). Carefully considering and implementing these elements can significantly impact the overall effectiveness and success of the gamified experience (Zourmpakis, 2023).

Gamification elements such as badges, storytelling, visualization of characters, challenges, contests, points, and rewards can enhance the learning experience by promoting engagement, motivation, and enjoyment (Hellberg, 2023). The use of game-based mechanics and game thinking in education can lead to better learning outcomes and increased student engagement (Ester, 2023). However, the effectiveness of gamification in education shows varying results, with some studies indicating that gamification can be manipulative or superficial if not implemented correctly (Hellberg, 2023).

Ecotourism with technology intervention

We extend the SCOPUS database on "ecotourism with technology intervention" data starting from 2000 until 2023. There are only 16 related papers were found Table 1.

Table 1

SCOPUS database on ecotourism with technology intervention

Citation metrics	
Publication years	: 2000-2023
Citation years	: 24 (2000-2024)
Papers	: 16
Citations	: 383
Cites/year	: 15.96
Cites/paper	: 23.94
Cites/author	: 383.00

We refined the literature from with citation years as of February 27, 2024. According to Table 1, it is reported that there are limited number of research papers on "ecotourism with technology intervention" found in the SCOPUS database can be attributed to several factors. Firstly, the intersection of ecotourism and technology is a relatively niche area of study that combines aspects of environmental science, tourism, and information technology. This multidisciplinary approach may not yet be widely recognized or explored within the academic community, leading to fewer publications (Huang et al., 2023). Additionally, the rapid evolution of technology means that research in this area can quickly become outdated, possibly deterring researchers from focusing on this topic.

There are significant gaps in ecotourism research that need to be addressed. For instance, there is a need for studies that evaluate the effectiveness of technology interventions in enhancing the sustainability of ecotourism projects (Dincă et al., 2023). Research is also needed to understand the impact of technology on the visitor experience in ecotourism settings, including how it influences their environmental awareness and behavior (Okan et al., 206). Furthermore, studies that assess the socio-economic impacts of integrating technology into ecotourism, particularly on local communities, are crucial (Sun et al., 2021). Positive views on the integration of technology in ecotourism include the potential for enhancing visitor engagement and education about environmental conservation. Technology can provide interactive and immersive experiences that deepen visitors' understanding of ecological and cultural values (Dincă et al., 2023). Additionally, technology can aid in the efficient management of ecotourism sites, enabling better resource conservation and visitor flow management to minimize environmental impacts (Huang et al., 2023).

In conclusion, while the integration of technology in ecotourism presents opportunities for enhancing environmental education and site management, it also poses challenges related to environmental impacts, visitor experience, and accessibility for operators. Addressing the gaps in research on this topic is essential for developing sustainable and effective ecotourism practices that leverage technology responsibly (Huang, 2023; Dincă, 2023; Okan et al., 2016; Sun et al., 2021; Cordon et al., 2021). With this intention, this study try to incorporate the meaningful gamification through the technology intervention.

Gamification in tourism

According to the search from the SCOPUS database on gamification in tourism, the search portrays 154 results (Table 2) related to gamification in tourism out of recent years starting from 2020 until 2024 (Figure 5).

Table 2

SCOPUS database on gamification in tourism.

Years of Publication	Number of Publication
2020	33
2021	30
2022	45
2023	40
2024	6 and still on going

Gamification in tourism is a design approach intended to increase motivation, enjoyment, and involvement with specific products and service users in non-game contexts. It uses a variety of game design patterns, such as badges, rewards, leaderboards, feedback, missions, and progress, to enhance

user experience and engagement. In the context of tourism, gamification is expected to increase tourists' satisfaction levels by providing better access to desired services, social recognition, effective time management, and virtual collaborative learning experiences while touring a destination. It also enhances services and systems by creating game-like experiences that help motivate users to perform positive actions and actively participate in learning activities based on the database.
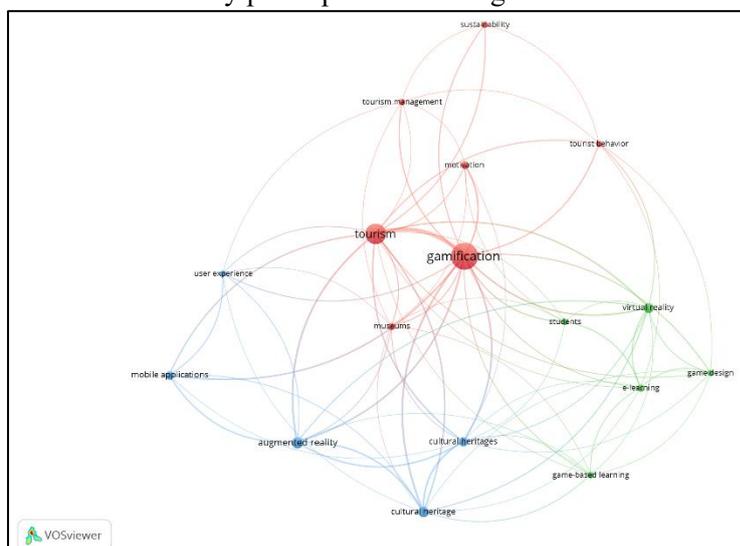
Figure 7
Network visualization of gamification in tourism year 2020-2024

According to **Figure 7**, gamification has seen significant growth and development from 2020 to 2024, with a focus on three main clusters with 16 items in total. The break down of Cluster 1, depicts 7 items; cluster 2 has 5 items and cluster 3 listed 4 items. Details of these clusters as shown in Table 3:

Table 3
SCOPUS database on gamification in tourism cluster and item year 2020-2024

Cluster	Item
1	gamification
	motivation
	museums
	sustainability
	tourism
	tourism management
	tourist behavior
2	e-learning
	game design
	game based-learning
	students
	virtual reality
3	augmented reality
	cultural heritage
	mobile applications
	user experience

Cluster 1: Gamification in tourism

The use of gamification in the tourism industry has gained traction as a way to enhance visitor experiences, increase engagement, and promote sustainability. By implementing game-like elements,

such as challenges and rewards, in tourist activities and museum exhibits, organizations can motivate visitors to learn and explore more actively. This approach has shown to influence tourist behavior positively, leading to greater participation in sustainable tourism practices. With the integration of gamification into tourism management, destinations can create more immersive and memorable experiences for travelers, ultimately boosting visitor satisfaction and loyalty. Studies have identified a range of motivations for ecotourists, including nature appreciation, health benefits, escape from daily life, and social interaction (Carvache-Franco et al., 2021). These motivations can be leveraged through gamification to create personalized and emotionally engaging experiences that resonate with different tourist segments. For instance, gamified activities that emphasize social interaction can cater to tourists motivated by building personal relationships, while those focused on nature can appeal to tourists seeking to enjoy and learn about the environment (Carvache-Franco et al., 2021). The segmentation of ecotourism destinations based on tourist motivations is crucial for developing targeted strategies that enhance visitor satisfaction and encourage repeat visits. By understanding the specific desires and interests of different tourist groups, ecotourism providers can create gamified experiences that align with these motivations, potentially leading to more responsible environmental behavior (Carvache-Franco et al., 2021). However, it is important to note that the impact of gamification in tourism is still a relatively new concept, and there is limited empirical research on its effectiveness, especially related to gamification in tourism behavior. It is proven with the database shown in Table 4. While some studies have shown positive benefits, such as increased knowledge gain and loyalty towards cultural heritage sites, the overall consensus on its efficacy in a tourism context is still unclear. It obviously can be interpreted that study in tourism related to behavior is inadequate, by listing up the studies within 2020-2024 only 1 paper each year, in contrast with 2022, reportedly 2 papers found and 0 for 2023.

Table 4

SCOPUS database on gamification in tourism related to behavior.

Years of Publication	Number of Publication related to behavior
2020	1
2021	1
2022	2
2023	0
2024	1

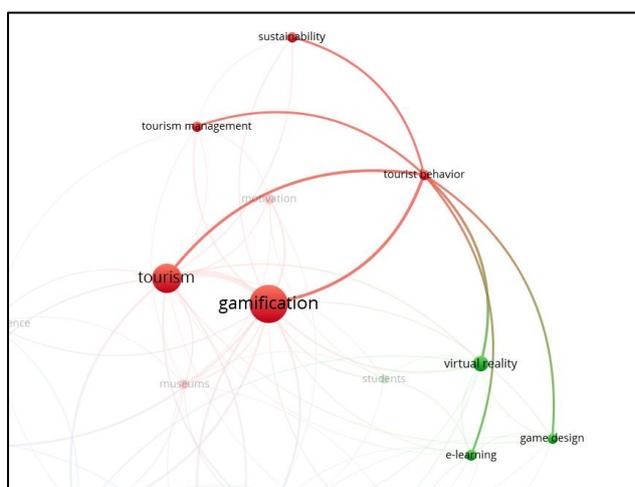**Figure 8**

Network visualization of gamification in related to behavior 2020-2024

Cluster 2: Gamification in E-Learning and Virtual Reality

The application of gamification in education (Figure 8) has gained momentum in recent years, aiming to improve student motivation, engagement, and learning outcomes. By incorporating game elements, such as points, badges, leaderboards, and levels, into academic activities, educators can create a more interactive and enjoyable learning environment. This approach has been found to increase students' intrinsic motivation and interest in various subjects, leading to enhanced knowledge retention and academic performance. Furthermore, gamification can facilitate personalized learning experiences, catering to individual students' needs and learning styles. Research by (Huseinović, 2024) demonstrated the positive effects of gamified learning in improving students' motivation and achievement in educational settings. Within the realm of education, gamification has been increasingly utilized to enhance e-learning and engage students in interactive learning experiences.

Furthermore, research has highlighted the importance of integrating educational components into gamified ecotourism experiences. By educating tourists about the ecological and cultural significance of the destinations they visit, gamification can foster a deeper understanding and appreciation of the environment, which is essential for promoting long-term behavior change (Cui et al., 2019).

Cluster 3: Augmented Reality and Cultural Heritage

The use of augmented reality in cultural heritage has opened up new possibilities for creating engaging and interactive experiences for users. Mobile applications leveraging AR technology enable users to explore and interact with cultural heritage sites and artifacts in ways that were previously impossible. This approach enhances user experiences by providing a deeper understanding of historical and cultural contexts, ultimately contributing to the preservation and promotion of cultural heritage.
These clusters demonstrate the diverse applications and benefits of gamification across different sectors, highlighting its potential to drive engagement, motivation, and learning experiences in various domains.

Ecotourism behavior

Ecotourism is a complex and multifaceted concept that has evolved significantly over the past few decades. At its core, ecotourism aims to promote responsible travel to natural areas, with the goal of conserving the environment and sustaining the well-being of local communities. The key aspects of ecotourism behavior, as highlighted related to it, includes nature-oriented travel and appreciation of natural environments where the visitation of comparatively undisturbed natural areas with the intention of appreciating and enjoying nature in an environmentally responsible manner. It extends to support for conservation efforts, learning and interpretation, socio-economic development of local communities, respect and support for local cultures, responsible and sustainable practices. By understanding and embracing these key principles, ecotourism can truly fulfill its potential as a sustainable and transformative form of tourism.

With this in mind, research database from Scopus in 2021 to 2024 as shown Table 5, has explored 996 documents asscociated with various aspects of ecotourism behavior, including tourist motivations, the impact of gamified experiences on behavior, and the role of education in fostering environmental stewardship.

Table 5

Scopus database on ecotourism behavior in 2021-2024

Citation metrics	
Publication years	: 2021-2024
Citation years	: 23 (2021-2024)
Papers	: 996
Citations	: 9839
Cites/year	: 3279.67
Cites/paper	: 9.88
Cites/author	: 4065.50

The search has been thoroughly visualised in network association as depicted in Figure 9 as it form 7 clusters with 167 item. There are immense items thatwe highlighted in the main visual that encompasses various aspects which we thought it obvious aspect to be paid attention to such as of environmental protection, ecosystem services, conservation management, pro-environmental behavior, heritage tourism, and sustainable environment.

Figure 9
Network visualization of ecotourism behavior 2021-2024

Figure 10
Network visualization of ecotourism behavior 2021-2024 based on country

According to Figure 10, the search has involved searching for relevant academic literature on the topic to provide a concise overview of ecotourism behavior trends and practices in various countries, namely, Portugal, South Africa, United States of America, Australia, Romania, Malaysia, Thailand, South Korea, Bangladesh, China and Europe. Ecotourism behavior is varies across different countries, with each region exhibiting unique trends and practices.

In Portugal, research has shown that lifestyle entrepreneurship initiatives can promote sustainable tourism in rural areas. These entrepreneurs often prioritize ecological responsibility, such as the use of renewable energy through biomass, which both produces energy and reduces waste (Duarte et al., 2023). Obtaining ecological certifications or ecolabels can also demonstrate a commitment to sustainable practices (Duarte et al., 2023).

Ecotourism in South Africa has gained significant attention in recent years as a sustainable approach to tourism that promotes environmental conservation and community development. From 2021 to 2024, several initiatives and research studies have highlighted the potential of ecotourism in the country. In

2021, a study explored the role of responsible tourism and alternative tourism in local climate change and ecosystem services management strategies in the Musina Municipality of South Africa (Chellik, 2023). The research emphasized the importance of raising awareness about the potential of ecotourism, sustainable agricultural systems, and integrated rural development to benefit local communities (Ramaano, 2023).

In the United States, ecotourism has become a significant source of foreign exchange and economic development, particularly in areas like Costa Rica and Guatemala. Ecotourism has been shown to have positive impacts on education, job training, hunting, and deforestation, as well as benefits to flora and fauna.

Australia has also focused on developing ecotourism in regional areas, leveraging its natural features, unique flora and fauna, and diverse cultural heritage. Ecotourism has been found to have a positive impact on environmental protection, wildlife conservation, poverty alleviation, and socio-economic development.

In Romania, the introduction of foreign experience in the recreational use of protected areas has been explored, it indicates that ecotourism has been gaining popularity in Romania, with the country hosting tourists from various European countries who visit to enjoy its ecotourism destinations (Milin, 2020). However, the research found that domestic Romanian tourists were less involved in ecotourism compared to international visitors. This suggests that Romania may be looking to foreign ecotourism models and experiences to help develop and promote its own protected area recreation and ecotourism offerings.

Overall, the global ecotourism sector has seen significant growth in recent decades, driven by increased environmental awareness and a desire for more sustainable tourism experiences. While the specific trends and practices vary across different countries, a common theme is the focus on balancing economic, environmental, and social considerations to promote long-term sustainability. Despite of these countries, it can be seen China (Figure 11) has taken ecotourism behavior seriously.

Figure 11
Network visualization of ecotourism behavior 2021-2024 in China

However, China has also faced significant environmental challenges due to its rapid economic development. The country has experienced severe air and water pollution, as well as the loss of wetlands, grasslands, and habitats for endangered species (Gao, 2019). To address these environmental issues, China has implemented the China Ecological Conservation Red Line (ECRL) initiative, which

aims to protect more than one-quarter of the Chinese mainland, an area almost the size of France, Spain, Turkey, Germany and Italy combined (Gao, 2019). The ECRL is designed to protect rare and endangered species and their habitats, as well as crucial ecosystem services and resilience to natural disasters (Gao, 2019).

Compared to other countries, China's approach to ecotourism and environmental protection appears to be more comprehensive and ambitious in scale based on the network visualization in Figure 9. While challenges remain, China's efforts to balance economic development and environmental sustainability through initiatives like the ECRL demonstrate a strong commitment to addressing the country's pressing environmental issues (Gao, 2019). China's commitment to ecotourism and environmental protection has become increasingly prominent in recent years. With its rich natural landscapes and diverse wildlife, China has recognized the importance of sustainable tourism practices to preserve and protect its natural environment. Ecotourism behavior in China encompasses a wide range of activities, including hiking in national parks, wildlife observation, and cultural immersion in rural communities.

The Chinese government has been actively promoting ecotourism as a means to support environmental conservation and local community development. In 2017, the National Development and Reform Commission of China issued guidelines to promote the sustainable development of ecotourism, emphasizing the importance of minimizing environmental impact, respecting local cultures, and supporting the livelihoods of indigenous communities.

In recent years, various regions in China have taken significant steps to integrate ecotourism into their overall tourism development China looks at ecotourism behavior as a significant aspect of sustainable tourism practices and environmental protection in all regions of the country. The Chinese government has been working towards promoting ecotourism through various initiatives and policies to ensure the preservation of its natural resources and biodiversity. In recent years, there has been a growing emphasis on the development of ecotourism in China, with efforts to mitigate the environmental impact of tourism activities while promoting responsible travel behavior via The Central Environmental Protection Inspection (CEPI), is a regulatory body responsible for monitoring and enforcing environmental protection measures. CEPI is seen as a crucial instrument for promoting the local adoption of responsibility for environmental protection (Jiang et al., 2024).

The implementation of ecotourism in China involves the integration of environmental conservation, community participation, and sustainable management of natural resources. This holistic approach aims to balance the economic benefits of tourism with the preservation of the natural environment and the well-being of local communities. As a result, ecotourism destinations in China offer unique opportunities for visitors to engage in environmentally friendly activities, such as nature walks, birdwatching, and organic farming experiences.

In line with China's commitment to ecotourism, ongoing research and studies have been conducted to assess the environmental, economic, and social impacts of ecotourism practices in various regions of the country. The latest references from 2022 to 2024 highlight the evolving strategies and best practices for ecotourism development in China, shedding light on key trends, challenges, and success stories in the field of sustainable tourism. These references serve as valuable resources for policymakers, researchers, and stakeholders to further advance ecotourism initiatives and promote environmental conservation in China.

Ecotourism in China encompasses a diverse range of activities that prioritize sustainable travel and environmental conservation. From the majestic mountains of Yunnan to the tranquil waters of the Li

River, China offers a wealth of natural landscapes for ecotourists to explore. One of the key aspects of ecotourism behavior in China is the promotion of responsible wildlife observation. Visitors have the opportunity to witness rare species such as the giant panda in their natural habitats, while also learning about conservation efforts to protect these iconic animals. Additionally, birdwatching tours allow travelers to appreciate the diverse avian species that call China home.

In line with the government's sustainable development goals, educational initiatives and awareness campaigns are also being implemented to encourage responsible travel behavior among tourists. These efforts aim to foster a sense of environmental administration and promote a harmonious relationship between visitors, local communities, and the natural world. The continued integration of ecotourism into China's broader tourism strategy reflects the country's dedication to preserving its natural beauty while reaping the benefits of sustainable travel. With ongoing research and evolving policies, China's ecotourism initiatives are poised to set new standards for responsible and immersive travel experiences.

In conclusion, China's commitment to ecotourism is evident in its proactive efforts to promote sustainable travel practices, minimize environmental impact, and support the well-being of local communities. The integration of ecotourism into China's broader tourism strategy reflects the country's dedication to preserving its natural beauty while reaping the benefits of responsible travel. Through ongoing research, evolving policies, and educational initiatives, China's ecotourism initiatives are setting new standards for immersive and sustainable travel experiences. As visitors engage in ecotourism practices, they not only contribute to the preservation of the natural environment but also foster a sense of environmental stewardship and support the livelihoods of rural populations. With the development of eco-friendly infrastructure and a focus on responsible travel behavior, China is paving the way for a harmonious relationship between visitors, local communities, and the natural world.

Meaningful Gamification for Ecotourism behavior

Meaningful gamification in ecotourism behavior refers to the integration of gameful design elements into ecotourism experiences to encourage sustainable practices among tourists. This approach aims to enhance the intrinsic motivation of tourists by providing them with engaging, enjoyable, and meaningful interactions with nature, ultimately leading to positive behavior change towards the environment. Research database from Google Scholar in 2021 to 2024 (Table 6), has explored 200 documents asscociated with various aspects of ecotourism behavior (Figure 12), including tourist motivations, the impact of gamified experiences on behavior, and the role of education in fostering environmental management.

Table 6

Google Scholar database on meaningful for ecotourism behavior in 2021-2024

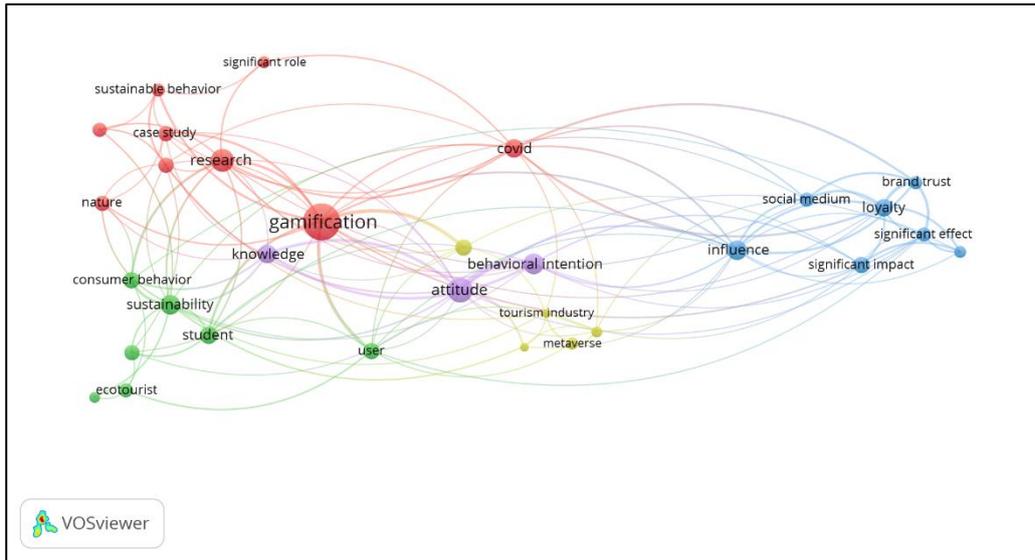| Citation metrics	
Publication years	: 2021-2024
Citation years	: 3 (2021-2024)
Papers	: 200
Citations	: 2058
Cites/year	: 686.00
Cites/paper	: 10.29
Cites/author	: 737.45
h-index	: 22

Figure 12

Network Visualization of meaningful for ecotourism behavior in 2021-2024

Table 7

Cluster on meaningful for ecotourism behavior in 2021-2024

Cluster	Item
1	cases study
	covid
	gamification
	nature
	research
	significant factor
	significant role
	sustainable behavior
	tourist behavior
2	consumer behavior
	ecotourist
	significant difference
	student
	sustainability
	sustainable behavior
	user
3	brand trust
	influence
	loyalty
	place identity
	significant effect
	significant impact
	social medium
4	consumer behavior
	metaverse
	tourism industry
	tourist behavior
	use
5	attitude
	behavioral intention
	knowledge
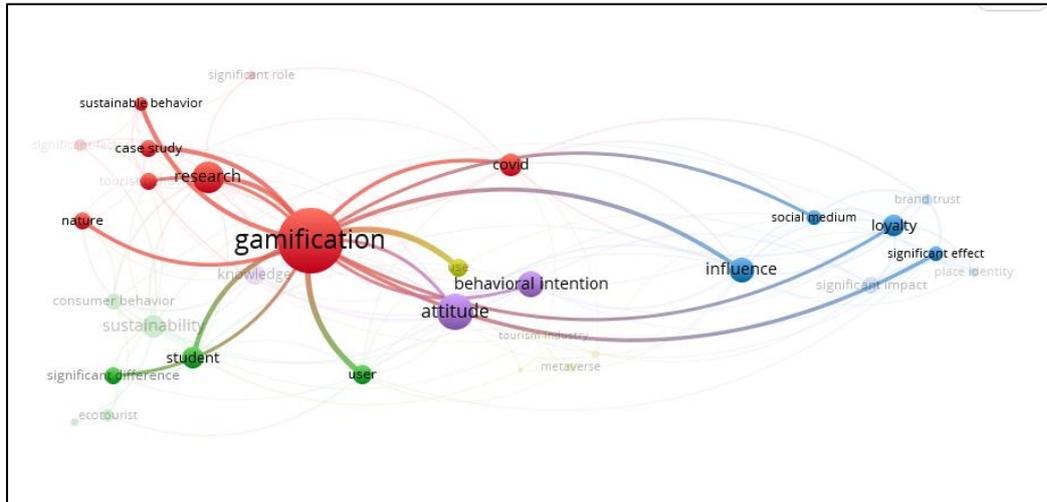
Figure 13
Network Visualization of meaningful gamification related to ecotourism behavior

Table 7 displays 5 clusters consist of 31 items that have been identified in the context of significant gamification in ecotourism behavior from 2021 to 2024. Their associations are visualized in Figure 13, gamification has been shown to have a significant relationship with behavioral intention and can impact sustainable ecotourism behavior. Research from 2022 to 2024 indicates that gamification mechanisms positively correlate with customer engagement, satisfaction, and intention in the banking industry (Gautam, 2022). Additionally, gamification has been found to positively impact intrinsic motivation and customer engagement across various industries (Imam, 2021). This suggests that incorporating gamification elements into sustainable ecotourism experiences could significantly influence visitors' behavioral intentions and promote more sustainable behaviors.

Furthermore, we investigated the perspectives of both tourists and ecotourism operators to gain a comprehensive understanding of the implications of meaningful gamification on ecotourism behavior. Delving into the potential of meaningful gamification for ecotourism behavior requires a comprehensive understanding of the underlying principles and mechanisms that drive its effectiveness. By examining the psychological and behavioral theories that underpin gamification, we can gain valuable insights into how game design elements can influence tourists' attitudes and actions towards conservation and sustainable practices. Furthermore, considering the diverse contexts in which ecotourism operates, it is essential to explore the adaptability and scalability of meaningful gamification strategies across different environmental and cultural settings. By analyzing case studies from various ecotourism destinations and conducting surveys among tourists, we can gather nuanced perspectives on the impact of gamified experiences on their behavior and the overall success of conservation initiatives.

Additionally, the use of gamification in ecotourism can enhance the overall experience for travelers, fostering a deeper connection with nature and local communities. Through interactive challenges, scavenger hunts, and educational quests, tourists can gain a greater appreciation for the natural environment and understand the importance of preserving it for future generations.

As the field of gamification continues to evolve, further research is needed to explore the long-term effects and scalability of gamified interventions in sustainable ecotourism. Understanding the psychological mechanisms behind gamification's impact on behavioral intention and sustainable practices can contribute to the development of more effective and tailored strategies for promoting eco-

friendly tourism. Recently, scholars have also explored the possible disadvantages and restrictions of gamification in the context of sustainable ecotourism. Although gamification has demonstrated potential in influencing immediate behaviors and attitudes, it is necessary to evaluate its long-term viability and enduring effects on tourists' ecological footprint and conservation mindset, extending beyond the immediate gamified experience.

Furthermore, it is important to investigate the impact of cultural nuances and individual variances on how people respond to gamified interventions in ecotourism. Various demographic cohorts may exhibit divergent responses to gamification components, and comprehending these subtleties might guide the development of more comprehensive and efficacious gamification tactics for heterogeneous visitor audiences. In light of these considerations, future research could employ a mixed-methods approach to examine the interplay between gamification, behavioral intention, and long-term sustainable ecotourism behaviors. Combining quantitative analyses of behavioral outcomes with qualitative insights from tourist experiences can offer a comprehensive understanding of the nuanced effects of gamification within the ecotourism context. Ultimately, advancing knowledge in this field will not only contribute to the theoretical understanding of gamification's role in sustainable ecotourism but also provide practical implications for the development of innovative and impactful interventions aimed at fostering environmentally conscious behaviors among tourists. Gamification's impact on sustainable ecotourism behavior is a multi-faceted and intricate subject that requires a deeper exploration of its underlying mechanisms. The influence of gamification on behavioral intention and ecotourism practices extends beyond the immediate context of engagement and motivation. Understanding the psychological and emotional drivers that lead individuals to embrace sustainable behaviors through gamified experiences is key to developing lasting and impactful interventions.

Further research is required to investigate the lasting impact and potential to be expanded of gamified treatments in sustainable ecotourism as the field of gamification progresses. Gaining insight into the psychological mechanisms that drive the influence of gamification on behavioral intention and sustainable practices might aid in the creation of more efficient and customised tactics for encouraging eco-friendly tourism. Recently, scholars have also explored the possible disadvantages and constraints of gamification in the context of sustainable ecotourism.

Ultimately, the study on the influence of gamification on sustainable ecotourism behavior highlights the significance of comprehending the psychological, emotional, and cultural elements involved. Through analysing the inherent drive and feeling of achievement stimulated by gamification, academics can cultivate authentic and long-lasting dedication to ecotourism practices. Adapting gamification tactics to align with various cultural backgrounds is essential to promote inclusivity and maximise effectiveness. Essentially, between 2021 and 2024, the emphasis in ecotourism has been on using gameful design to leverage the various incentives of tourists, providing captivating and informative experiences, and promoting ecologically responsible actions. The effectiveness of these gamified experiences relies on a sophisticated comprehension of tourist motivations and the efficient incorporation of educational content to stimulate a long-term dedication to environmental conservation(Carvache-Franco et al., 2021; Cui et al., 2019).

DISCUSSION

Meaningful gamification in ecotourism is indeed a crucial aspect that requires attention. The use of gamification in ecotourism can significantly enhance visitor experiences and promote sustainable practices. However, the current research indicates that the implementation of meaningful gamification

in ecotourism behavior is still limited and needs to be further explored and developed based on the results obtained through scholarly databases and portrayed in bibliometric analysis.

The concept of meaningful gamification in ecotourism is particularly important as it can help in addressing the challenges and opportunities in promoting sustainable ecotourism practices. By incorporating meaningful gamification strategies that are meaningful and relevant to the ecotourism context, it is possible to enhance visitor education and awareness, as well as encourage pro-environmental behaviors (Carvache-Franco et al., 2021).

Recent studies from 2020 to 2024 have also highlighted the significance of meaningful gamification in ecotourism. These studies have emphasized the need for innovative gamification strategies that can effectively engage ecotourists and motivate them to participate in sustainable practices, thus nurture the intention to improve their ecobehavior. For instance, the segmentation of ecotourists based on their motivations can help in designing gamified experiences that are tailored to their specific interests and preferences.

Meaningful gamification can play a significant role in promoting ecotourism behavior, particularly in countries that are actively addressing environmental impact, tourism management, environmental sustainability, and cultural/heritage protection. However, based on the context provided, it appears that China is the only country that has taken serious action on environmental protection and environmental responsibility in this domain. It is associated with the CEPI and has had a significant impact on the local community in terms of promoting environmental responsibility. Upon contemplation of this application, it is associated with meaningful gamification that aims to induce behavioral change with a focus on pro-environmental actions. Considering this, there is a similar endeavour to duplicate and cultivate the younger generation in China using technology, such as mobile applications, which can influence their eco-tourism behavior, especially during their cultural and heritage visits. Additionally, the meaningful gamification which involves integrating game-like elements in the application such as rewards, points, and challenges into non-game contexts, has been shown to effectively engage individuals and motivate them to adopt more sustainable behaviors (Shahzad et al., 2023). In the context of ecotourism, meaningful gamification can be used to increase awareness of environmental issues, foster a sense of community and social connection among eco-conscious travelers, and make the experience more enjoyable and entertaining (Shahzad et al., 2023)

The context suggests that while many countries are giving attention to the environmental impact, tourism management, environmental sustainability, and cultural/heritage protection, China appears to be the only one that has taken significant steps to address these issues (Shahzad et al., 2023).China has been actively promoting pro-enviromental technique and introducing user-friendly policies to encourage green consumption behaviors, including the use of gamification to engage the younger generation in sustainable practices. By all means, meaningful gamification has been shown to be an effective tool for promoting ecotourism behavior, particularly among university students, who are considered an important target group due to their technological savvy and high interest in environmental issues. Studies have found that gamification can positively influence green consumption behavior by increasing technological awareness, hedonic motivation, and perceived enjoyment, and that virtual corporate social responsibility (CSR) can further enhance these effects.

Meaningful gamification can have a significant impact on nurturing youth towards ecotourism behavior. Research shows that gamification can increase awareness of environmental issues and motivate sustainable consumption choices among young people. By incorporating game elements like rewards,

challenges, and social interaction into ecotourism initiatives, gamification can make sustainable practices more engaging and enjoyable for the younger generation. Additionally, gamification can foster a sense of community and social connection around environmental goals, further reinforcing eco-friendly behaviors. However, further research and innovation in this area are needed to fully realize the potential of meaningful gamification in ecotourism behavior.

The interpretation and discussion of results from the latest research papers underscore the importance of meaningful gamification in ecotourism behviour. It is evident that the development of effective gamification strategies, informed by the motivations and behaviors of ecotourists, is essential for promoting sustainable practices and enhancing the overall ecotourism experience. By leveraging the engaging elements of game design, such as feedback systems, progress tracking, and rewards, gamification transforms learning and behavior change into a more enjoyable and motivating experience. Through meaningful gamification can instill key ecological concepts and encourage the development of emotional intelligence and a respectful curiosity about the environment. When youths are actively engaged in gamified activities that underscore the importance of sustainability and environmental behavior, they are more likely to adopt practices that contribute to the preservation of our ecosystem. Consequently, gamification represents a promising approach to fostering a generation that is both knowledgeable about and actively involved in environmental protection.

In conclusion, the context suggests that while most countries are giving attention to environmental impact, tourism management, environmental sustainability, and cultural/heritage protection, China appears to be the only one that has taken serious action on environmental protection and environmental responsibility, including the use of gamification to engage the younger generation in sustainable practices. The evidence from the literature indicates that meaningful gamification can be a powerful tool for promoting ecotourism behavior, particularly in countries like China that are actively addressing these critical environmental and sustainability issues. Overall, the use of meaningful gamification strategies has the potential to significantly impact youth engagement towards ecotorism behavioral participation in ecotourism and other sustainable practices.

CONCLUSION

Synthesis of Research Findings

This study embarked on a systematic bibliometric analysis to explore the intersection of meaningful gamification and ecotourism behavior, scrutinizing global trends and publication patterns from 2020 to 2024. The primary objective was to determine if specific gamification components are being utilized to foster sustainable behaviors within ecotourism and to assess their reported effectiveness. The analysis, grounded in data from Scopus and Google Scholar, reveals that while gamification has permeated various sectors such as education, marketing, and healthcare, its application within the specific niche of "ecotourism with technology intervention" remains relatively nascent and underexplored3.

The bibliometric mapping explicitly highlights a divergence between "gamification" and "meaningful gamification." The literature indicates a critical shift from merely employing game mechanic, for instance points, badges, and leaderboards toward "meaningful gamification," which prioritizes intrinsic motivation, user autonomy, and long-term engagement. The findings underscore that while standard gamification elements can drive short-term engagement through extrinsic rewards, they often fail to sustain long-term behavioral change. Conversely, meaningful gamification, which integrates elements of play, exposition, choice, information, engagement, and reflection, aligns more closely with Self-

Determination Theory, thereby fostering a deeper, more autonomous connection between the tourist and the environment.

The Ecotourism-Technology Gap

A significant conclusion drawn from the network visualization is the scarcity of research specifically targeting technology interventions in ecotourism. The analysis identified only a limited number of papers directly addressing "ecotourism with technology intervention" between 2000 and 2023. This suggests that the multidisciplinary fusion of environmental science, tourism management, and information technology has not yet reached maturity within the academic community.

Despite this gap, the potential for technology to revolutionize ecotourism is evident. The literature supports the view that gamified mobile applications and augmented reality can transform passive sightseeing into active, immersive learning experiences. These technologies can serve as vital tools for destination management, helping to regulate visitor flows and minimize environmental impact while simultaneously enhancing the educational value of the visit. However, the study identifies a pressing need for empirical research to evaluate the actual effectiveness of these interventions in real-world settings, particularly concerning their influence on pro-environmental behavior and the socio-economic well-being of local communities.

Global Trends and the Role of Policy

Geographically, the bibliometric analysis reveals varied approaches to ecotourism behavior across different nations. While countries like Portugal, South Africa, and Australia have focused on lifestyle entrepreneurship, rural development, and biodiversity conservation respectively, China emerges as a distinct and significant actor in this domain. The network visualization and literature review highlight China's rigorous approach to balancing rapid economic development with environmental sustainability through large-scale initiatives like the China Ecological Conservation Red Line (ECRL) and the Central Environmental Protection Inspection (CEPI).

The data suggests that China is uniquely positioned in its adoption of gamification strategies to cultivate environmental responsibility, particularly among the younger generation. By leveraging the technological savvy of youth, specifically university students. Chinese initiatives are successfully utilizing meaningful gamification to increase awareness of environmental issues and motivate green consumption behaviors. This top-down integration of policy with bottom-up technological engagement provides a compelling model for other nations, demonstrating how gamification can be operationalized not just as a marketing gimmick, but as a strategic instrument for national environmental governance and cultural preservation.

Implications for Behavioral Change

The core theoretical implication of this study is that for gamification to be effective in ecotourism, it must transcend entertainment. The "meaningful" aspect is derived from the ability of the system to generate reflection and emotional connection. The study confirms that emotional experiences and destination image are pivotal in satisfying ecotourists and prompting environmentally responsible behavior. Gamification strategies that facilitate social interaction, allow for personal choice in learning paths, and provide narrative exposition (storytelling) are more likely to result in the internalization of sustainable values. Furthermore, the study highlights that behavioral change is not a monolithic process; it requires segmentation. Different tourists have different motivations which ranging from nature

appreciation to social bonding and gamified systems must be adaptive enough to cater to these diverse drives. The successful application of meaningful gamification lies in its capacity to transform the tourist from a passive observer into an active participant in conservation, thereby creating a "shared value" for both the visitor and the destination.

Future Research Agenda

In light of the identified gaps and emerging trends, this study proposes a robust agenda for future research. First, there is an urgent need for longitudinal studies to assess the long-term persistence of behavioral changes induced by gamification. Current research is often cross-sectional or short-term; understanding whether gamification leads to lasting pro-environmental habits requires observation over extended periods. Second, future investigations should employ mixed-methods approaches. Combining quantitative metrics of behavioral outcomes with qualitative insights into tourist experiences will provide a more nuanced understanding of how and why specific game elements trigger meaningful psychological shifts. Third, research must address the cultural scalability of these interventions. As indicated by the diverse global practices, gamification strategies that work in one cultural context may not be effective in another. Understanding the influence of cultural nuances and demographic variables is essential for developing inclusive and globally applicable ecotourism strategies.

In conclusion, this bibliometric review establishes that while the integration of meaningful gamification in ecotourism is still in its formative stages, it holds transformative potential. By shifting the focus from "gamifying for engagement" to "gamifying for meaning," tourism operators and policymakers can foster a new generation of travelers who are not only entertained but are also educated, emotionally connected, and intrinsically motivated to protect the natural world. The synthesis of game design principles with sustainable tourism goals represents a promising frontier for both academic inquiry and practical application, offering a viable pathway toward mitigating the environmental footprint of tourism while maximizing its educational and social benefits.

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