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The Enhancement of Climate Change Science Communication and Understanding Through Glacier Tourism

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THE ENHANCEMENT OF CLIMATE CHANGE SCIENCE COMMUNICATION AND UNDERSTANDING THROUGH GLACIER TOURISM

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

THE ENHANCEMENT OF CLIMATE CHANGE SCIENCE COMMUNICATION AND UNDERSTANDING THROUGH GLACIER TOURISM

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The natural environment provides the opportunity for educators to teach the general public about scientific topics that are misunderstood. Arctic tourism has increased as accessibility to these regions has improved. Informal learning is a valuable yet extremely understudied phenomenon within the tourism industry. Iceland is a country that lies in the North Atlantic and has experienced a significant increase in foreign visitors over the past decade. Of the natural features in Iceland, glaciers have become a top attraction for visitors. Since thousands of visitors participate in guided glacier tours annually in Iceland, an opportunity to couple glacier tourism with informal education is created. This study utilized a mixed-methods approach of pre- and post-outcome assessments, semi-structured interviews, and observations to evaluate tourist perceptions during a guided glacier tour at three popular destinations in Iceland: Sólheimajökull, Into the Glacier, and Jökulsárlón. This project aimed to assess the outcomes and applicability of informal environmental education to teach about climate change during a guided glacier tour. Results identified that learning outcomes were similar among sites. Each guided glacier tourism experience is unique in nature, but collectively produced individuals that had widened perspectives and increased understanding of glaciers and climate change.

Chapter 1: Introduction

In recent years, tourism has grown rapidly and expanded to places that were once less accessible to the general public. As tourism-related activities have expanded, so have the various versions of the tourism endeavor; one example is the introduction of nature-based tourism, also known as ecotourism. Nature tourism involves travel to natural areas with the intent to enjoy and appreciate nature and the scenery (Sæþórsdóttir 2010), allowing for insight into the environment and the ability to reconnect with nature on a personal level (Kuenzi and McNeely 2008). Arctic tourism, or cold-climate tourism, involves travel to polar regions for business trips, urban tourism, or nature-based excursions (Barre et al. 2016). Arctic tourism can be considered a sub-section of nature-based tourism. Arctic tourism involves a variety of locations around the world, but a place of particular interest to tourists in recent years is Iceland.

Referred to as the land of fire and ice, Iceland is well known for its incredible landscape of volcanoes, lava fields, fjords, and glaciers (Sæþórsdóttir et al. 2017). Iceland's landscape offers many economic benefits through mass fishing, renewable energy, and growing tourism activities. There are various nature-based activities available within Iceland and other Arctic locations, such as viewing the aurora borealis, whale watching, and visiting glaciers. Glacier landscapes have become their own branch of tourism, introducing activities such as glacier hiking, ice-climbing, kayaking, and boating (Yuan and Wang 2018). Glacier tourism has received increased tourism attention in recent years in part because of global trends in glacial retreat (Welling et al. 2015). Specifically, glacial retreat has led to the development of "last-chance tourism," which involves visiting destinations before they disappear entirely (Lemelin et al. 2010).

Iceland is experiencing a rapid increase in last-chance tourism activity since glaciers are a considerable part of the country's landscape; yet, despite the growing interest in polar tourism, research on glacier tourism is lacking (Welling et al. 2015). Due to this lack of research, there is a lacuna of information available that discusses what tourists are learning when taking part in a guided glacier tour. Additionally, research discussing how glacier tourism activities can be used not only to entertain tourists but also to educate about climate change science is lacking, despite glaciers serving as visual evidence for the impacts of a warming global climate.

Environmental education has regularly been defined and used throughout literature for many years and draws upon the importance of developing citizens that are motivated towards environmental concerns (Stapp 1969). Environmental education can occur through formal, non-formal, and informal learning settings; informal learning is of particular relevance to this study. Informal learning consists of non-course-based activities expressed from individual interests (McGivney 1999); it is unintentional and can be unorganized yet can account for a large portion of a person's lifetime learnings (Coombs and Ahmed 1974). Guided glacier tours, through the application of informal environmental education principles and methods, present an opportunity to understand how tourists respond to and perceive climate change science, educate about glaciers, improve scientific understanding of climate change, and develop a citizenry more engaged in environmentally-friendly lifestyles. Yet, further research on the applicability of informal learning and environmental education during a guided tour is needed to use glacier tourism as a mechanism for climate change education.

1.1 Research Purpose and Questions

The objective of this research was to develop a comprehensive understanding of tourist perceptions during guided glacier tours in Iceland. Specifically, this research assesses the outcomes and applicability of informal environmental education to teach about climate change and glacier science during a guided glacier tour. Last-chance tourism is an increasing occurrence in Arctic regions, notably Iceland, as tourists rush to see glaciers before warming atmospheric temperatures diminish the ability to explore these unique landscapes. Climate change science is still poorly understood among members of the general public (Brulle and Dunlap 2015), so glacier tours could serve as an avenue through which to promote climate science and engage citizens in living climate-responsible lives. Published literature on environmental education and informal learning in Arctic landscapes, and especially glacier tourism, is lacking. This research has the potential to advance knowledge in the environmental field by expanding on the topics of environmental education and glaciers, contributing to the growing field of glacier tourism, and establishing this field as an essential avenue for environmental and climate change education. Results of this study should help answer the following questions:

- How can glacier tourism activities, through the principles and practices of informal environmental education, be used as a venue through which to improve understanding of climate change science?
- In what ways, if any, are guided glacier tour experiences in Iceland communicating environmental topics to improve general knowledge of

glaciers and their vulnerability to climate change and degradation by mass tourism activities?

- How does the type of glacier tour experience (e.g., hiking tours across a glacier, traversing through a glacier, or exploring a glacier lagoon) influence educational outcomes and visitor perceptions of climate change?
- In which ways do perceptions of educational outcomes of a glacier tour experience differ between glacier guides and visitors on their glacier tours?

To answer the aforementioned questions, pre- and post-outcomes assessments and semi-structured interviews were distributed to and conducted with glacier tourists and their guides. Data were collected from three glacier tourism experiences: hiking tours across a glacier, traversing through a glacier, or exploring an actively forming glacier lagoon. Results were used to determine how informal learning is utilized during guided glacier tours in Iceland. Additionally, data were collected and analyzed to identify how science interpreters can include environmental topics within existing guided tours. Iceland serves as a case study site for this research, as the country's tourism industry offers visitors multiple different glacier experiences and has experienced almost four times the number of foreign visitors since 2010 (Óladóttir 2018). Additionally, in a survey conducted by Óladóttir (2018) asking what gave tourists the idea to visit Iceland, 92.4% responded saying it was the country's natural features; of this percentage, 17% were most attracted to the glaciers. The results of this case study allow for understanding which informal education practices are being used when guiding large populations of diverse tourists through glacier-based activities, ultimately creating an opportunity to promote best educational and environmental practices for use

not only in Iceland, but also other regions experiencing rapid growth and expansion in glacier tourism sectors. In short, this study aimed to develop a better understanding of the crucial relationship between glacier tourism and environmental education, so the two topics can be coupled effectively to promote better tourism planning and management in the glacier-tourism industry.

Chapter Two: Literature Review

Nature-based tourism is rapidly expanding in modern tourism planning and management activities (Kuenzi and McNeely 2008). A variety of different forms of nature-tourism exist, but the one of most interest for this research is glacier tourism; yet, research on glacier tourism and its relation to environmental education is lacking (Welling et al. 2015). This study aims to develop a better understanding of the critical relationship between glacier tourism and environmental education. This understanding can lead to the two topics being coupled effectively to promote better planning and management in the glacier-tourism industry and increase knowledge of glaciers in individuals participating in glacier tourism.

2.1 Climate Change

The early narrative on climate change began with discoveries from Swedish chemist, Svante Arrhenius. In the early 1900s, Arrhenius hypothesized that an increase of CO_2 in the atmosphere may result in a warming climate; yet, scientists were not able to investigate this connection until after World War II (Malone 2002). Postwar, many countries pursued scientific collaboration at international levels, resulting in "a global network of atmospheric observing and measurement stations under the newly formed World Meteorological Organization" (Malone 2002, 155). Scientific investigation advanced in 1975 when geochemist, Charles David Keeling, developed a monitoring station in Mauna Loa, Hawaii that measures the level of CO_2 in the atmosphere, thus revealing an alarming level of increase (Malone 2002; Harris 2010). Between the 1960s and 1990s, research and monitoring continued at both national and international scales,

with the Intergovernmental Panel on Climate Change (1990) formed in 1988 (Malone 2002), which would eventually publish significant findings on climate research.

Climate change has been the forefront of many societal and scientific debates for the last two decades. This debate is often attributed to determining whether a warming climate is a result of natural or anthropogenic forces. In 1990, the IPCC Working Group I published its first Scientific Assessment of Climate Change. This report first introduces the concern that human activity may be contributing to a changing climate, emphasizing the sudden increase of greenhouse gases (IPCC 1990). Three decades later, "the evidence and confidence in observed and projected ocean and cryosphere changes have grown," specifically anthropogenic-caused warming (IPCC 2019, 13).

Climatic changes occur as a "result of variations to components of the climatic system" (Smith 1993, 730). Greenhouse gas (GHG) emissions are considered to be one of the main contributing factors to rising global temperatures (IPCC 2013) due to the emission of carbon dioxide (CO_2), methane, water vapor, and nitrous oxide (Rodhe 1990; IPCC 2013) into the atmosphere. The IPCC (2013) suggested that GHGs are a significant contributor to the observed warming over the last 50 years. While some climatic changes will occur naturally over time, the rate at which they occur has resulted in concern, as "many of the observed changes are unprecedented over decades to millennia" (IPCC 2013, v). Smith (1993) discussed that water vapor is the most important of all the greenhouse gases, yet it represents any type of warming in the atmosphere and is not influenced by anthropogenic emissions. CO_2 has a higher concentration in the atmosphere than any other GHG, which is largely a result of

anthropogenic forces (Smith 1993; IPCC 2013) from industrial growth, fossil-fuel use, and land-use change (Nicholls and Klein 2005).

A changing climate can result in physical attributions, which include, but are not limited to, shifts in seasons, warming water bodies, coastal erosion, ocean acidification, and melting glaciers (Rosenzweig et al. 2008). As climate change impacts worsen over time, communities who are impacted the most will have to develop mitigation and adaptation efforts. For example, coastal zones around Europe are threatened by sea-level rise, which can lead to erosion and increased flooding; therefore, having socio-economic impacts on the community (Nicholls and Klein 2005). In addition, Arctic regions are incredibly susceptible to the effects of climate change (Welling et al. 2015; Stewart et al. 2016; Björnsson 2017).

The Earth's cryosphere responds quickly to fluctuations in temperature across large timescales. Both oceanic and cryosphere conditions experience seasonal melting and varied temperatures due to the El-Niño-Southern Oscillation (ENSO) (IPCC 2019). These natural forces, along with geologic occurrences such as earthquakes or volcanic eruptions, can play large roles in climatic variability of a location; yet, the growth of the industrial revolution and increased production of greenhouse gases in the atmosphere has heavily influenced the global temperature over time (IPCC 2019).

Glaciers all around the world are experiencing retreat (IPCC 2019). Glaciers are sensitive to climate variability, and current climate imbalances are resulting in a higher risk of glacial recession, even if temperatures become more balanced in the future (IPCC 2013; Wang and Lan-Yue 2019). The rate and magnitude of cryosphere changes are projected to increase into the 21st century (IPCC 2019). Physical cryosphere changes

resulting from warming temperatures are predicted to increase the risk for tourism and recreational assets (IPCC 2019). Climate change and global temperature rise "represents one of the most significant challenges to humanity in the 21st century and is anticipated to have major consequences for climate-sensitive tourism highly dependent on glaciers" (Wang and Lan-Yue 2019, 72). Such consequences would include accessibly, safety, overall experience, and more (Figure 2.1). Furthermore, glacier recession as a result of climate change has impacted tourism operations due to the increased occurrence of natural hazards (Smiraglia et al. 2008; Welling and Abegg 2019); yet, it is emphasized within the literature that there is an urge to understand better existing and future climate-change impacts on glacier tourism, and develop adaptation strategies for stakeholders and visitors (Welling et al. 2015; Stewart et al. 2016). Therefore, educating visitors on current and future risks could be a beneficial outlet in guided glacier tour experiences. Climate change education was emphasized heavily in Article 6 of the United Nations Framework Convention on Climate Change (UNFCCC 1992), which prioritized six main activities of interest: "education, training, public awareness, public access to information, public participation, and international cooperation" (Reid 2019, 768). The key objectives of the educational scope were to modify long-term habits and foster climate change understanding; yet, there is still a lack of effective climate change communication (Reid 2019). While most individuals acknowledge climate change, there is a lack of educators engaging in expanding knowledge on climate change and the scope in which they communicate the topic (Blum et al. 2013; Berger et al. 2015; Reid 2019), which "contributes to the deepening climate crisis, as do the funding and policy priorities of many educational ministries, providers, practitioners, and research

associations" (Reid 2019, 770). Thus, using voluntary tourism experiences as an outlet for climate change education may deem itself as an effective way to spark conversations on climate change.

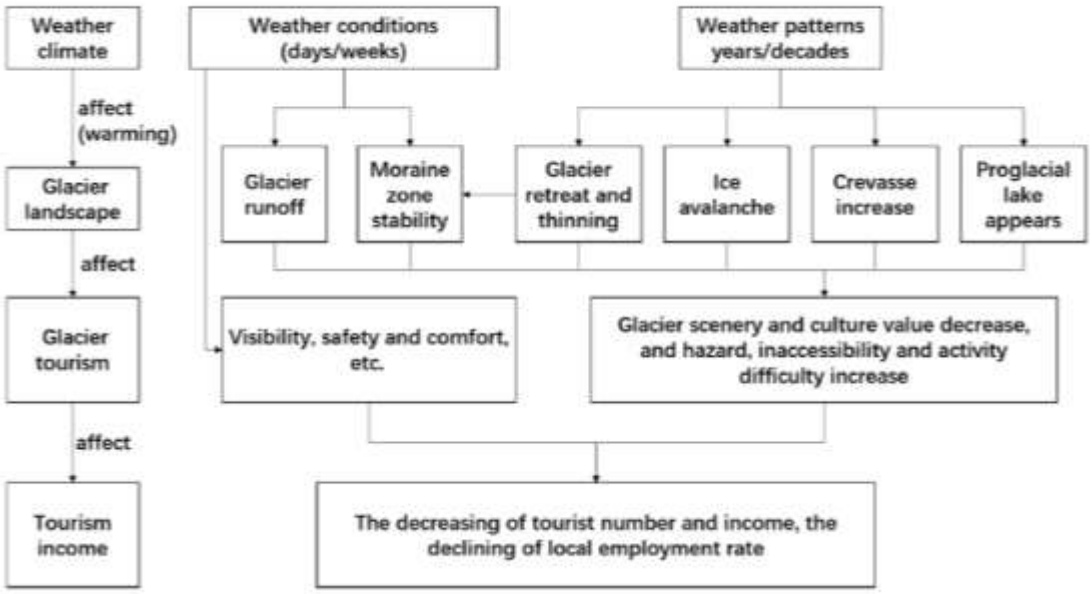


Figure 2.1: Impact of climate change on glacier landscapes and glacier tourism activities (Source: Wang and Lan-Yue 2019).

2.2 Globalization

Globalization can be defined in many ways but is simply known as the interaction and integration amongst politics, people, industries, or markets of various countries (Dayananda 2019). Globalization is well-cited in literature, as it is "the key idea by which we understand the transition of human society into the third millennium" (Waters 1995, 1). Early definitions of globalization were also crafted by Giddens (1990) and Robertson (1992), with a distinct difference among the two. Giddens (1990, 64) described globalization as "the intensification of worldwide social relations which link

distant localities in such a way that local happenings are shaped by occurring many miles away and vice versa," while Robertson (1992, 8) explained that globalization "refers to both the compression of the world and the intensification of consciousness of the world as a whole." Robertson (1992, 8) argued that globalization should not be considered a "consequence of modernity," which is implied in Gidden's (1990) definition, but rather a condition that "facilitated" it (Malone 2002, 145). Through globalization, the movement of goods, services, and investments could expand (Theuns 2008).

Climate change, in general, is a crucial component of globalization. It can be discussed within an economic, political, and cultural scope. From an economic standpoint, one may consider capitalism and consumerism, and the use of natural goods; while the political perspective may assess the growth of modernity (Malone 2002). Table 2.1 crafted by Malone (2002) is a matrix that uses examples to classifies approaches towards climate change in the realm of globalization. Furthermore, globalization has influenced both the environmental movement and tourism. Through the growth of globalization and the increased ability for transboundary development, environmental concerns have risen. This topic is often controversial, as the growth of industry, coupled with the lack of environmental regulations in some nations, has resulted in environmental concerns and challenges (Christmann and Taylor 2002). Regarding tourism, specifically, globalization has played a significant role in the development of tourism endeavors across the globe.

Table 2.1: Dimensions of climate change (Source: Malone 2002, 145).

	Economic aspects of climate change	Political aspects of climate change	Cultural aspects of climate change
Global versus national or local	GATT, ITO, NAFTA, etc. v. national environmental standards	Modern bureaucracy clashes with national traditions, e.g., Chipko movement	Concern for global climate v. issues of responsibility for the problem and equity between nations
Global domination in content/form	Capitalist world system mires some nations in poverty & vulnerability to climate change	Transnational social movements, standard state forms, "ecological modernization"	Western science and scientists define the problem & solutions
Hybrids and pastiches	Emissions trading systems, ecological economics, sustainability	Green parties seek to reduce emissions	"Local knowledge" added to scientific knowledge

2.3 Tourism

Modern tourism dates back to the 16th century, as a means to travel for amusement, experience, education, and relaxation (Gyr 2010). With the rise of industrialization in the early 1900s, tourism became much more accessible to those other than just the wealthy and began to fit in with modern culture and lifestyles (Gyr 2010). Means of travel have developed rapidly since the 1700s. In 1758, the first known travel agency, Cox and Kings, was established. In the mid-1800s, the first leisure travel agency was created, encouraging Britons to see more of the world. Then, the 1900s led to opportunities through rail and air travel (Westcott 2019). The 1960s, specifically, were a

crucial decade for tourism development, as many travel companies began to emerge and compete for customers, resulting in the introduction of mass tourism (Gyr 2010; Westcott 2019). Today, tourism is one of the world's largest economic sectors (Figure 2.2) and plays a crucial role in economic development and employment generation (Dayananda 2019; WTTC 2019).

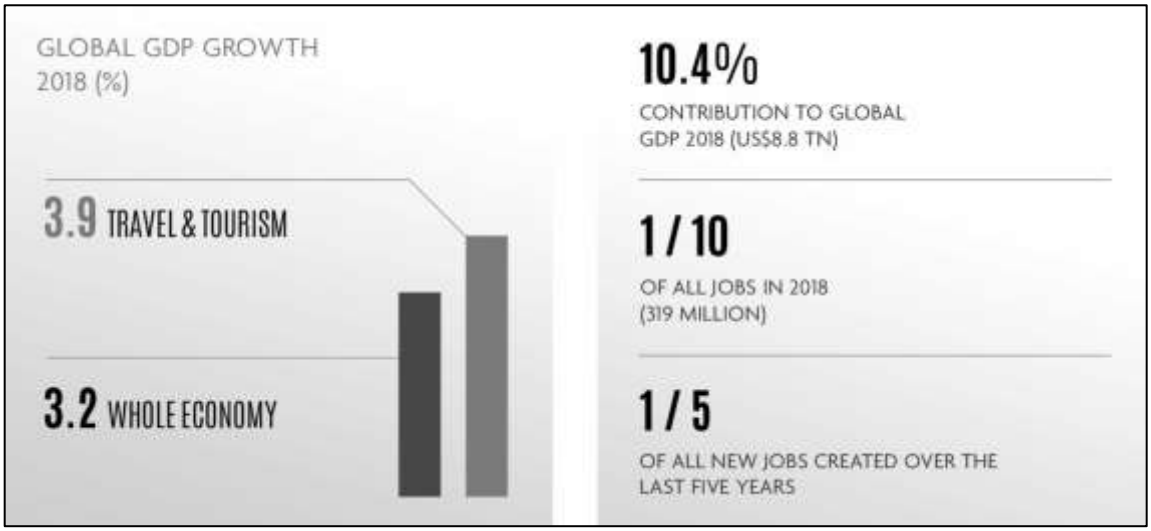


Figure 2.2: Contribution of tourism sector to World economy and employment (Source: WTTC 2019, 1).

Since the rise of industrialization, tourism has advanced significantly, benefiting local economies and countries worldwide. In 2017, international tourist arrivals increased seven percent worldwide from the previous year, far above the United Nations' World Tourism Organization's prediction of 3.8% growth per year between 2010 and 2020 (WTO 2018). Within the same year, destinations that had suffered lower tourism numbers previously from security challenges witnessed quick recovery, and others saw sustained growth (WTO 2018). In 2019, tourist arrivals reached 1.5 billion, a growth of 4% from 2018; this is less than in previous years, yet many regions still

experienced growth in arrivals (WTO 2020). The World Tourism Organization predicts that tourism will continue to grow throughout the upcoming decades but at a more sustainable pace. As such, it is clear that tourism is a well-established endeavor, improving local economies, creating jobs, increasing exports and development, and enhancing cultural and environmental protection and preservation (Morrison et al. 2018; WTO 2018; WTO 2020).

Tourism has resulted in valuable socio-economic benefits for local economies and communities by promoting jobs, enhancing local cultures, and educating tourists (Morrison et al. 2018). One of the largest tourism industry sectors is leisure tourism, which involves any individual traveling to relax, experience new places, and broaden their mindset. In 2019, leisure tourism spending reached 4.71 billion USD (Lock 2020). In addition to an approved economy, tourism can lead to a variety of cultural benefits. As foreign visitors travel to new regions, cross-cultural communication may occur, which can evolve into better understating between the tourists and the hosts. Furthermore, being within a new culture can improve understanding and tolerance of that community (Besculides et al. 2002), which may result in environmental awareness and free-choice learning, allowing the tourist to learn more about that place (Falk 2005).

While many advantages occur in the realm of tourism, the practice has also resulted in disadvantages, particularly concerning its impact on the environment. For example, factors such as overcrowding and development can have adverse effects on a destination. Overcrowding can result in environmental stress and degradation of the environment. Increased development, while sometimes necessary, can be disruptive to the visitors' experience by reducing the aesthetic value or harming the natural

environment (Valentine 1992). Archer et al. (2005) imply that there is a lack of research and understanding of the negative environmental consequences of tourism activity. As a suggestion, Butler (1990) offered research priorities for practitioners and researchers in the tourism field, including creating a better understanding of tourism in general, integrating environmental education within tourism, developing assessments on the impacts of tourism, and developing plans on how to increase sustainability in the long-term. Fortunately, more recent literature does acknowledge the disadvantages that result from tourism and attempts to fix these issues with management plans. Specifically, in the past twenty years, increased attention has been placed on tourism impacts revolving around social, cultural, economic, and environmental influences (Kuenzi and McNeely 2008; Barre et al. 2016), yet, education through tourism is still understudied. With improved management plans, increased educational outreach can better improve tourists' understanding of the culture and environment in which they are located.

2.3.1 Nature-Based Tourism

Nature-based tourism can be described as travel to natural areas with the motivation of enjoying and appreciating nature and the scenery (Sæþórsdóttir 2010). Nature-based tourism has only recently been actively defined throughout modern literature, with definitions varying widely depending on the individual defining it. Despite the acceptance of a single, concise definition of nature-based tourism, consistent trends within the themes of various definitions do exist. For example, Sæþórsdóttir (2010, 28) defined nature-based tourism as "travel to natural areas with the main motivation being to enjoy the scenery and appreciate nature," while Kuenzi and

McNeely (2008, 1) explained that nature-based tourism is “excursions to national parks and wilderness areas, to developing countries where a large portion of the world’s biodiversity is concentrated.” Buckley (1994) even argued that a single definition would be too restrictive since the practice involves many various components. Nonetheless, although definitions found in contemporary literature differ in wording, they all generally gravitate around the importance of nature and individuals being within the natural environment.

Ecotourism is often discussed in the literature and used interchangeably with nature-based tourism (Wall 1994). While nature-based tourism and ecotourism each can also be known as alternative tourism or sustainable tourism, differences between the two terms still exist. As seen in Table 2.2, various components within each definition exist. For example, management goals differ from one another since ecotourism involves preservation and resource protection, while nature-based tourism involves conservation and resource management. These two differences are important to note because ecotourism efforts seek that visitors observe, learn, and appreciate the natural environment they are in to promote conservation and education themes (Caneday and Duston 1992). Furthermore, ‘ecotourism’ or ‘sustainable tourism’ “anticipate certain outcomes of tourism activities by attaching quality criteria to them” (Kuenzi and McNeely 2008, 3). Due to this, some sub-themes of nature-based tourism cannot always be considered sustainable or ‘eco’ (Kuenzi and McNeely 2008).

Table 2.2: Definitions of ecotourism and nature-based tourism (Source: Dawson 2008, 42; adapted from Ziffer 1989).

Definition components	Ecotourism	Nature-based tourism
Management goals	Preservation and protection of the resource	Conservation and resource management
Primary resource use	Natural resources and natural history of the area, including its indigenous cultures	Natural resources, natural history, and the present and historic cultures of the area
Primary tourist motivation	Visit an ecosystem or undeveloped natural area for appreciation and to experience the environmental conditions	Visit an undeveloped natural area for appreciation and to directly experience the environmental conditions or indirectly as a background for a consumptive or non-consumptive recreational experience
Recreational activities	Non-consumptive appreciation and study of wildlife and natural resources	Non-consumptive appreciation and study of, and consumptive use of, wildlife and natural resources.
Economic contribution of tourism to area	Directly and indirectly contributes to the visited area which supports the protection orpreservation of the site and the economic well-being of the local residents	Directly and indirectly contributes to the visited area which supports the conservation of the site and the health of the local economy
Visitor appreciation	The visit should strengthen the tourist's appreciation and dedication to preservation and protection issues at the visited area and in general	The visit should strengthen the tourist's appreciation and dedication to conservation issues at the visited area and in general
Management of the public/ private area	Implies a managed approach by the host country or region which commits to establishing and maintaining the area with the participation of local residents, marketing it appropriately, enforcing regulations, and using the economic benefits to fund the area's land management as well as community development	Implies a managed approach by the public and private sectors which commits to establishing and maintaining the area, marketing it appropriately, enforcing regulations and using the economic benefits to fund the area's land management

Interest in nature-based tourism may be a result of people suddenly feeling a disconnect from the natural environment due to the force of a more urban lifestyle (Kuenzi and McNeely 2008). Nature-based tourism allows for a more intimate insight into nature and the ability to reconnect with nature on a personal level. Additionally,

nature-based tourism encompasses a robust educational component (Laarman and Perdue 1988) and includes programs that educate individuals on topics such as conservation management (Valentine 1992). A study conducted by Dunkley (2016) revealed that botanical gardens act as an effective venue to help visitors recognize the role of plants within an ecosystem, promote insight and reflection towards the ecological crisis. Nature-based tourism excursions can take place around the globe and include an abundance of different activities.

Valentine (1992) discussed multiple instances of successful and sustainable nature-based tourism activities from a case study at an island bird sanctuary, located on the coast of Wales at Skomer Island. This sanctuary, managed by the West Wales Naturalists Trust, has a quota for visitors and local, mainland citizens provide the accommodations. An example from Michaelmas Cay on the Great Barrier Reef discussed how the location was meant initially for seaplane landings, but since has become prohibited due to the presence of breeding birds. Instead, tourists visit by boat and participate in activities such as snorkeling and diving. Additionally, Kuenzi and McNeely (2008) explained that visits to national parks and developing countries with extensive biodiversity are also important components of nature-based excursions. De Urioste-Stone (2015) conducted a study of tourist perceptions on climate change impacts at the Acadia National Park in Maine, U.S. and revealed that many guests do believe climate change will affect the area and are concerned with negative climate impacts. Furthermore, the study concludes that while future research is necessary, climate change will likely impact tourism behavior at Acadia National Park. While research involving

these topics has increased recently, there are limited studies focusing on the two topics coupled together (Brownlee et al. 2013; De Urioste-Stone 2015).

While nature-based tourism sounds more environmentally friendly than just 'tourism,' nature-based tourism does have negative impacts on a region that must be considered. Some potential adverse effects of nature-based tourism include development projects that hinder the aesthetic values of the landscape and overcrowding, which stress the environment and can cause irritation during tourists' visits (Valentine 1992). Valentine (1992) further discussed various ways to sustain ecotourism by ensuring the activities have a sustained and adequate benefit to the local community, linking the destination and the locally protected nature, promoting management skills that cater to both the tourists and the local community. To protect against adverse outcomes of nature-based tourism, it is also essential to communicate to visitors how they can have a smaller impact on the environment. This type of knowledge can be best spread through informal education during nature-based tourism excursions.

2.4 Tourism in the Arctic

Nature-based tourism involves any natural part of the world, yet tourism in cold-climate regions has witnessed growing interest, particularly within the Arctic (Stewart et al. 2005), crafting Arctic tourism, or polar tourism, as yet another sub-section of nature-based tourism. Geographically, the Arctic is considered to be the region above the Arctic Circle, surrounding the North Pole (NSIDC 2020a). While similar to nature-based tourism, most publications have created their own definitions of Arctic tourism. For example, Stewart et al. (2005, 385) defined this tourism as "travel for pleasure and

adventure within polar regions, exclusive of travel for primarily government, commercial, subsistence, military, or scientific purposes." Historically, Norway participated in tourism ventures starting as early as 1845, when its use of steamship tours established the very beginnings of tourism ventures before any other polar region (Stewart et al. 2005). Until the late 19th century, polar regions were considered remote and inaccessible (Snyder and Stonehouse 2007), as they were "geographically isolated" (Stewart et al. 2017, 60), resulting in the general public having little understanding of these landscapes.

Comprehensive research and publications about Arctic tourism overall is scarce (Jóhannesson et al. 2010), since early research of polar tourism was conducted by individuals who had visited the polar regions and conducted "opportunistic and sporadic research that was geographically piecemeal" (Stewart et al. 2017, 60). In the 1960s-70s, Arctic communities were slowly beginning to embrace tourism opportunities, which are now increasingly expanding through commercial cruising ventures (Stewart et al. 2017). It was not until the 1990s that many important texts related to the growing interest of Arctic tourism and similar issues were produced. The first of these publications was an issue of the *Annals of Tourism Research,* which gathered various papers discussing the challenges of balancing the environment, science, and tourism (Stewart et al. 2005). The first edited book on polar tourism, written by Johnston and Hall (1995), titled *Polar Tourism: Tourism in the Arctic and Antarctic Region* synthesized growth patterns, monitoring impacts, regulations, and sustainable management tools. As a result, polar tourism was finally established as a legitimate area of research activity (Stewart et al.

2005; Stewart et al. 2017). Travel to Arctic regions is now common and accessible nearly everywhere.

The last decade has allowed for "tourism research to diversify geographically and phenomenological" (Stewart et al. 2017, 60). This geographic diversity has led to the legitimacy and maturity of polar tourism as a sub-section of tourism. As research and accessibility have grown, evaluating and studying the sub-sectors of Arctic tourism, and all that they encompass has become much easier. More specifically, recent publications detail various realms of Arctic tourism, rather than just defining the topic as a whole. Johnston and Hall (1995) stated several predictions regarding Arctic tourism, which include polar tourism continuing to grow, an increase in environmental concerns, and visitor growth being nearly impossible to halt in polar regions. After examining current literature, such as Óladóttir's (2012-2020) yearly reports on Iceland's tourism statistics or Lemelin et al. (2010), which addressed the growing prevalence of last-chance tourism, these predictions seem to hold. Additionally, Wang and Lan-Yue (2019) declared that Arctic tourism is expected to develop rapidly in the future, stressing the importance of continuing research on polar tourism to manage future concerns effectively. Furthermore, Arctic tourism numbers reach 20-30 million annually, far exceeding the local populations (Wang and Lan-Yue 2019); therefore, as visitor growth increases, it is up to interpreters and science educators to inform citizens on environmental concerns and their ever-increasing footprint on these regions to maximize learning outcomes and more sustainable lifestyles best.

Within the Arctic, there are various activities to take part in that act as integral components of the tourist experience. Arctic tourism, in general, includes intraregional

travel, business trips, urban tourism, and nature-based excursions (Barre et al. 2016). Focusing explicitly on nature-based excursions, most Arctic regions consist of beautiful landscapes, wildlife, and unique cultures for visitors to experience, making polar-regions the prime location for nature-based travel.

One of the most popular natural attractions in Arctic regions are glaciers. As the majority of tourists who visit Arctic regions do not commonly have access to them, glaciers are the top attractions for visitors because "tourists are frequently attracted to unusual environmental settings" (Snyder and Stonehouse 2007, 9). While Arctic tourism has become much more recognized and accepted in literature, and scientific information on glaciers is well established, glacier tourism research, specifically, is still in its infancy. Yet, glacier tourism could play a vital and important role in improving the general public's understanding of both glaciers and climate change.

2.4.1 Last-Chance Tourism

Last-chance tourism endeavors can occur as a result of various environmental degradations. Through heightened media recognition, such as the Annual IPCC report, campaigns like the International Polar Year (2007-2009), or through the acclaimed documentary by Al Gore, *An Inconvenient Truth*, climate change understanding increased amongst the public (Eijgelaar et al. 2010). Additionally, as popular tourism destinations began to realize climate change could directly impact their environment, they pushed for media attention in travel magazines as "must-see endangered destinations" (Eijgelaar et al. 2010, 338). For example, tourism has increased in Queensland, Australia, as a result of the heightened concerns of the Great Barrier Reef

being threatened by the impacts of climate change (Piggott-McKellar and McNamara 2016). Last-chance tourism in the Arctic, specifically, has increased significantly in recent years. Through heightened media attention, coupled with books and publications related to the phenomenon, the Arctic has been the center of last-chance tourism endeavors, as "the potential loss of these unique polar landscapes through global climate change provides a rationale for some tourists to visit these areas before they disappear" (Lemelin et al. 2010, 478).

While climate change is often considered a negative phenomenon, it has benefited the tourism industry in some regards. Since the prevalence of last-change tourism has led to increased visitors within particular regions, it has deemed itself beneficial for the host-countries economy and tourism development. Many tourism operations have been able to market their attractions as a "last-chance opportunity," which often will bring in many visitors (Lemelin et al. 2010). Also, climate change degradation, such as melting sea-ice, is predicted to result in easier accessibility to certain Arctic regions, leading to visitors seeing features not visible before (Lemelin et al. 2010; Dawson et al. 2007). In contrast, climate change impacts on tourism can have adverse outcomes as well. Many destinations have been forced to restructure to keep the attraction in place (Eijgelaar et al. 2010). In addition, tourism operators may struggle to promise certain tourist features that are disappearing. An example mentioned in Lemelin et al. (2010) described a visitor taking a German cruise that promised "meter-thick pack ice." During the visitor's cruise, the ice was not present because it had all melted. This disappointment resulted in the visitor winning a court case against the tour operator because what had been promised in the brochure was not there. Similar disappointment

from attractions has been present in various regions around the globe (Lemelin et al. 2010). Thus, tourism companies that operate “last-chance” attractions are presented unique challenges when determining how to maximize profits and tourism experiences while also being gentle on the natural environment. Table 2.3 displays the consequences and responses of tourism industries to climate change impacts. While research on last-change tourism is available within literature, “researchers are yet to explicitly focus on ‘last-chance’ tourism experiences in alpine glacier environments within a protected area management context” (Stewart et al. 2016, 380).

Table 2.3: Response of arctic tourism sector to climate change in polar regions (Source: Adapted from IPCC 2019).

Sector/System	Consequences of climate change	Documented Responses	Key assets and strategies of adaptive and transformative capacity	Anticipated future conditions/level of certainty	Other forces for change that may interact with climate and affect outcomes
Tourism (Arctic and Antarctic)	Warmer conditions, more open water, public perception of 'last chance' opportunities	Increased visitation, (quantity and quality) increase in off-season tourism to polar regions	Policies to ensure safety, cultural integrity, ecological health, adequate quarantine procedures	Increased risk of introduction of alien species and direct effects of tourists on wildlife	Travel costs. Shifting tourism market, more enterprises

2.4.2 Glaciers and Glacier Tourism

The cryosphere is one of the major components of the Earth system, consisting of sea ice, lake ice, snow cover, ground cover, glaciers, and ice sheets (Benn and Evans 2010). Glaciers are made of fallen snow that has compressed into large ice masses over time. Glaciers are considered to be the largest freshwater source in the world (USGS 2016). The Randolph Glacier Inventory, which is a compilation of data about all the world's glaciers, indicates there are 198,000 glaciers in the world, covering about 10%, or 762,000 km², of the Earth's surface (RGI Consortium 2017). For a glacier to be present, there must be specific climate and geographic conditions; they are usually found above the snow line, or in regions with intense snow in winter seasons and cool summers (NSIDC 2020b). Glaciers can be seen on nearly every continent, but are most commonly found in Antarctica and Greenland, where most of the world's glacial ice is located (NSIDC 2020b). The Randolph Glacier Inventory concludes that 44% of the world's glacierized areas are within the Arctic regions (RGI Consortium 2017).

Glaciers are unique landforms that come with many complexities, and they are also extremely vulnerable to changing weather patterns, both seasonally and over long-term scales. Not only can scientific evidence show proof of this change, but glaciers also offer incomparable physical and visual evidence of such retreat (Welling et al. 2015). Glaciers are "undoubtedly tangible evidence that our planet's climate is changing" and this increased pace is creating awareness in visitors (Welling et al. 2015, 645). Glacial retreat can have a variety of effects on the surrounding landscape. For example, as a glacier retreats, ice volume fluctuation can lead to a change in surface morphology.

Additionally, glacial thinning can result in slope steepening, which increases crevassing and stress on the glacier. Lastly, the decrease in surface elevation causes increased melt rates due to higher temperatures at lower elevations (Purdie 2013). As these changes occur, the risk and vulnerability of tourists visiting glacial sites increases significantly; this suggests that when comparing climate influences on glaciers and tourism, there is a unique connection between the two. This increased rate of glacier retreat throughout the world gives tourists visible evidence that the climate is changing and proves that climate can directly impact tourism. In some cases, climate has decreased the number of tourists in areas due to changes in accessibility and risks of hazards (Welling et al. 2015), but, more commonly, tourism numbers have actually increased as tourists rush to cold-climate destinations to see glaciers before they are melted. Fortunately, increased tourism in these regions also offers opportunities for data collection and monitoring about the glacier themselves (Barre et al. 2016).

Glacier tourism, commonly seen as a subset of nature tourism or polar tourism, involves activities such as glacier hikes, boating on glacial lagoons, and watching glacial calving (Welling et al. 2015). A study by Welling et al. (2015) interpreted the available resources on glacier tourism and listed various authors' definitions. Some of these definitions included: 'tourism activities in glacier areas' (Lui et al. 2006), 'activities where glaciers serve as the main attraction' (Wang and Jaio 2012), 'walking and climbing on glaciated areas for the unique experience' (Furunes and Mykletun 2012). More recently, glacier tourism has been defined as any activity that takes place on the glacier or within adjacent areas, such as the pro-glacial zones; these pro-glacial zones are the fore fields in front of, or just beyond, the actual glacier, derived from glacier ice

and consist of landforms such as moraines, icebergs, or pro-glacial lakes that have a unique blue appearance (Welling et al. 2015). The areas surrounding a glacier are of equal importance to the actual glacier because they attract tourist activity without physically being a glacier. Specifically, Welling et al. (2015) stated that pro-glacial zones offer different viewing perspectives, allowing visitors to view features and processes from afar and to understand any geological and climatological processes better. Therefore, when developing an understanding of scientific knowledge while at these glacier sites, both the glacier and surrounding areas must be included.

Nordic countries and northerly latitude locales, such as Iceland, the Faroe Islands, Sweden, Finland and Norway, which have many glaciers and unique landscapes accessible for visitation by travelers, are of specific interest for glacier tourism research. Nordic countries have the potential to serve as models of tourism management and education. Glacier tourism in these areas has increased significantly in recent years, which can also be attributed to interest in the natural beauty of glaciers and the sense of adventure they convey to tourists (Purdie 2013). An increase in visitors can be attributed in part to the idea of "last-chance tourism," also referred to as "catastrophe tourism," "climate tourism," or "extinction tourism" (Eijgelaar et al. 2010), which is considered to be visiting destinations before they disappear entirely; in the Arctic, much of this disappearance has been a direct result of warming climates (Lemelin et al. 2010; Olsen et al. 2012).

Despite the history of glacier tourism and the current increase in glacier tourism activity, the amount of available literature related to the topic of glacier tourism is minimal compared to other tourism disciplines; this is particularly true regarding

informal learning and environmental education through glacier tourism. Wang et al. (2010, 167) stated, “there is extensive literature on glacier geology and geography but relatively little involving glacier tourism.” Of the studies conducted, many have focused on tourists’ perceptions of climate change impacts or prevent the destruction of glaciers through direct tourism activities, rather the connection between glacier tourism and the promotion of climate change understanding. For example, at Baishui Glacier in Southwestern China, a study by Wang et al. (2010) created adaptation and mitigation strategies that prepared the glacier for climate change impacts. These mitigation strategies include optimizing the space layout, improving tourism planning and environmental protection, adopting protective measures and retreat tread, strengthening scientific research and promoting sustainable development, develop products and cater to the needs of tourists, reducing ecological pressure, and reinforcing public environmental education. Comparable adaptation measures were also discussed in the study done by Welling et al. (2015) and included strengthening scientific research on glacier and environmental protection, better understanding social capabilities such as reacting to glacial change, and reinforcing public education.

Garavaglia et al. (2012) conducted a questionnaire at Forni Glacier in Italy that helped better understand tourist perceptions on climate change impacts; the results revealed that most tourists’ awareness emerged from the survey itself or information spread through media. Garavaglia et al. (2012) stated that it is important to give tourists the information they need to understand and identify a changing climate and prepare for landscape changes. Additionally, results showed the importance of accurate planning to share scientific knowledge. The researchers concluded that comparisons should be made

in other geographic regions to fully grasp a universal understanding of tourist perceptions on climate change impacts. Similarly, Stewart (et al. 2016) emphasized the influence last-chance tourism has on tourism experiences at the Fox and Franz Josef glaciers in New Zealand through stakeholder interviews and visitor surveys.

Overall, glacier tourism research lacks when it comes to communicating how tourists learn during a guided glacier tour, yet published literature in glacier tourism, regardless of whether focused on protecting glaciers from tourism-induced degradation or perceptions of climate change, continuously mentions that creating awareness among tourists is the best way to promote glacial protection better. For example, Wang et al. (2010) suggested creating information boards about climate warming and glacial recession so visitors can reduce their impact, and guides can be more aware of environmental knowledge of climate change. Garavaglia et al. (2012) put forth that when using glacier tourism as a means for research and sharing scientific knowledge, it is necessary to know how tourists observe the environment's response to climate change, as well as their general background knowledge on glaciers. Without this information, it becomes more difficult to understand changes in tourist' perceptions on topics such as climate change after embarking on some glacier tourism activities.

2.4.3 Tourism in Iceland

Iceland lies north of the Atlantic Ocean, close to the Arctic Circle (Björnsson and Pálsson 2008), and has a population of roughly 356,000 (Statistics Iceland 2019). Tourism in Iceland began earlier than other Arctic regions, as European scientists began traveling to the country towards the end of the 18th century for research purposes,

eventually followed by travelers interested in the geologic landscape and other unique features (Sæþórsdóttir et al. 2011; Karlsdóttir 2013; Welling and Árnason 2016). Accessibility for travelers became possible by steamships in the late 1800s, and eventually through flying during the mid-20th century (Welling and Árnason 2016). Following the initial flights from Europe to Iceland, many other network routes were developed and began using Iceland's airport in Keflavík as a hub, inspiring the country to start developing tourism endeavors (Welling and Árnason 2016).

Due to the unique physical and human geography of Iceland, the country has become a major attraction for tourists (Sæþórsdóttir 2017). A report prepared by Óladóttir (2018) revealed the total number of international visitors by airport point of entry (excluding cruise ship passengers) was 2.2 million in 2017. In 2015, this number was at 1.2 million, indicating in just two short years over one million more people came to visit the country (Óladóttir 2017). More recently, Iceland experienced 1.7 million visitors between May 2019 and April 2020, indicating a decrease from previous years (Óladóttir 2020). Interestingly, despite the significant number of visitors in the past years, most Icelandic nature destinations were considered underdeveloped regarding tourism until very recently. Development is rapidly changing, with an increase in signage and construction projects (Sæþórsdóttir 2010; Graham 2020). The Óladóttir (2018; 2017) reports asked visitors their reason for visiting Iceland and concluded that the number one response was 'Nature.' In addition, subjective assessments done by Óladóttir (2017; 2016) on the effects of tourism, which asked locals if they agree or disagree with the various statements, indicated over 70% of those surveyed believe "tourist pressure on Icelandic nature is too high" (Óladóttir 2017, 28; Óladóttir 2016,

24); these percentages have continuously increased since the survey was first conducted in 2015. Almost every piece of literature related to Icelandic tourism discusses the marked increase of tourism trends within the country, and how it will only continue to increase well into the future (Jóhannesson et al. 2010; Óladóttir 2018; Welling and Abegg 2019); this trend helps highlight the necessity for scientists to conduct further research that helps spread information on how to adapt and educate tourists on the potential impacts they may have on the landscape.

2.4.4 Icelandic Glaciers and Glacier Tourism

Icelandic glaciers are classified as warm or temperate-based, and are dynamic, resulting in a high response rate to climatic changes. Most glacial meltwater feeds rivers, which are occasionally used for hydropower (Björnsson and Pálsson 2008). Research regarding glaciers and their role as indicators for climate change is one of the most significant glaciological studies to be done in Iceland (Björnsson and Pálsson 2008); therefore, a more "comprehensive research agenda might aim at the development of a coherent conceptual framework that incorporates the main elements of glacier tourism" (Welling et al. 2015, 651), as well as a basic understanding of glacier dynamics.

Through companies such as Guide to Iceland, Extreme Iceland, and Arctic Adventures, tourists can receive guided tours of Icelandic glaciers. Some of the most popular glacier-related destinations in Iceland include locations in Reykjavik, Sólheimajökull, and the Jökulsárlón area. As Lerche (2017) revealed, guides are experiencing challenges and daily struggles while guiding tours, such as climatic shifts that force guides to continually create new hiking routes that can sustain hundreds of

tourists. Additionally, meltwater is causing problems for tour groups trying to reach the glacier; bridges must be built over meltwater ponds to reach the destination. Despite tourism challenges, which are the direct result of climatic changes, there is uncertainty about whether or not tourists are aware of why the climatic changes and resulting challenges are occurring or how best to communicate about the relationship of climate change to glacier health.

2.5 Environmental Education

The primary antecedents of environmental education involve nature, outdoor education, and conservation education (Heimlich and Daudi 2002). While the term itself is well-established, environmental education has been defined differently for decades and continues to evolve to consider learning outcomes and the unpredictable nature of understanding (Heimlich and Daudi 2002; Falk 2005). Early definitions of environmental education are more detail-oriented and focus on various realms of the concept as a whole rather than merely stating the overall goal of practicing environmental education. For example, a definition from the Department of Resource Conservation and Planning at the University of Michigan declares environmental education as creating citizens who can solve problems and work towards solutions related to the biophysical environment (Stapp 1969). In contrast, the Environmental Education Act (U.S. Public Law 91-516, 1970) describes environmental education as the educational process between man and his relationship with natural, human-made surroundings (Heimlich and Daudi 2002).

In contrast to past definitions, the United States Environmental Protection Agency (EPA) more recently described environmental education as helping individuals or communities learn about the environment by increasing awareness and knowledge on various issues and problems (EPA 2018). Despite these varying definitions, the overall goal declared by Stapp (1969) remains the same: to develop a group of citizens that are knowledgeable, aware, and motivated towards environmental concerns. Stapp (1969) further communicates this statement by discussing primary objectives of environmental education; these objectives involve creating an understanding that man can alter the environment, the environment's role in the functioning of society, and environmental problems and solutions which result in motivated citizens participating in environmental problem-solving.

Environmental education allows individuals to make informed decisions on various environmental topics (EPA 2018). This field of education is distinctive in that it can be taught and learned effectively both inside and outside of a traditional classroom setting and through formal, non-formal, and informal education techniques, as most individuals regularly go beyond school settings to expand their knowledge of the world (Falk 2005). These three fields of learning date back almost sixty years and were developed "by individuals working in the area of international development as a means to distinguish the kinds of educational experiences individuals in developing countries had in the absence of an established compulsory education system" (Falk 2001, 7). Formal education, the most familiar concept to many individuals, is taught in the form of a specific standardized and structured system, consisting of classroom teachings from lower primary school extended through university settings (Coombs and Ahmed 1974).

Non-formal education occurs when learners want to take their knowledge further by participating in voluntary studies with someone who uses the curriculum, in a form such as a workshop, to help improve the person's self-determined interests (Livingston 2006). While formal and non-formal learning are important and relate to environmental education, the focus of this study will be informal education since "the future of environmental education lies in the understanding that it is a lifelong learning endeavor" (Ballantyne and Packer 2006, 291). Compared to literature on formal and non-formal learning, research regarding informal education is in its infancy.

As aforementioned, environmental education can occur outside of a traditional classroom, which introduces outdoor education as a broader subsection of informal environmental education. In the late 1920s, the Outdoor Education Movement created the belief that the outdoors can assist in reaching education-related goals by allowing people to have direct experience with the environment (Stapp 1974). Additionally, researchers have put forth that while indoor teachings are necessary and appropriate to an extent, information should also be learned through direct experience outdoors since individuals typically only spend three percent of their lifetime in traditional school settings (Falk and Dierking 2002); in short, the use of the outdoor environment is an essential way of improving the quality of education.

The outdoor education movement has produced two important spokesmen, Julian Smith and L.B. Sharp (Stapp 1974). Julian Smith was the director of the Outdoor Education Project, a "co-operative venture with the Associated Fishing Tackle Manufacturers and the Sporting Arms and Ammunitions Manufacturers Institute" (Smith 1956, 15). The project's overall purpose was to create leadership training

workshops and clinics informing attendees on outdoor education, develop interpretation of outdoor education and how it can be implemented within school settings, and to distribute proper instructions and guidelines for outdoor education (Smith 1956). In Sharp's (1947) paper discussing camping and the outdoors, he stated that outdoor education should be a necessary part of a school program. Additionally, Sharp (1947) argued three advantages related to learning from direct experiences: one learns faster, information is retained longer, and it leads to a better appreciation and understanding of the topic at hand. To this day, these beliefs hold true, as outdoor classroom settings, tourism excursions, zoos, aquariums, and botanical gardens are regularly used to achieve these educational goals (Falk and Dierking 2002; Ballantyne and Packer 2006).

2.5.1 Informal Learning

Environmental education is taught inside and outside the classroom, through formal, non-formal, and informal learning (Falk 2001); however, learning science through informal learning methods is an expanding area of study that has the potential to support a wide array of learning experiences (Bell et al. 2009). Informal learning, formerly known as free-choice learning, is a type of education that takes place outside the usual learning environment (Table 2.4) (McGivney 1999; Schugurensky 2000; Falk 2001; Ballantyne and Packer 2006). Informal education is non-course-based learning activities expressed from people's interest, or planned learning that is informal and responds to the interests of those involved (McGivney 1999). Informal learning endeavors are a lifelong process in which individuals develop skills and knowledge from daily experiences, from those people interact with, or from what people hear and see

from media or experiences. Informal learning is unorganized and sometimes unintentional; yet, it makes up a large portion of a person's lifetime of learning (Coombs and Ahmed 1974). According to Environment Australia (2000) individuals should have continued access and understanding of a wide array of informational sources to keep up with the constant changing and evolving environmental concerns.

Table 2.4: Formal vs. Informal Learning (Source: Adapted from North 2011).

Formal (In-School) Learning	**Informal (Out-of-School) Learning**
Captive audience	Non-captive audience
Mandatory Participation	Voluntary Participation
Instructional material both verbal (lecture format) and visual (textbook)	Instructional material primarily visual (exhibit and labels), except where guided tours provided
Sustained exposure to the learning material (ex: an entire semester)	Short exposure to learning material (typically 1-4 hours)
Time commitment is fixed	Time commitment is not fixed
Learning is externally motivated (grades, diplomas, licenses, money, jobs, advancement)	Learning is internally motivated (interest, fun, entertainment, self- improvement, passing time)
Learning assessed – external motivation	Learning not assessed
Learning explicitly controlled by a teacher	Learning explicitly controlled by the learner, exploratory in nature
De-contextualized	Contextualized (place-based)
Linear learning (learning occurs in a progressive manner that is controlled by a teacher)	Non-linear (audience can come and go and can review the educational materials at the site in any order)
Learning is a nonsocial event	Learning is more of a social event (motivated by social contribution)
Consequences of learning are often coercive (grades, punishment)	Consequences of learning are non- coercive (visitor selects experiences, no consequences if visitor fails to learn)
Audience is restricted by age and academic achievement	Audience is unrestricted
Wide focus of material	Narrow focus regarding a specific place, object, or subject
Typically federally evaluated and regulated	Typically not evaluated or regulated by federal-level agencies

Literature discussing informal learning consists of a variety of different describing points, yet, they are similar concerning key concepts and themes. Informal learning can either support or challenge knowledge acquired in formal and non-formal settings (Schugurensky 2000). Informal learning can occur in a variety of different contexts but works exceptionally well within environmental settings. Falk and Dierking (2002) state that most information can be learned through direct experience outdoors. For example, a study conducted by Orams (1997) tested the use of educational programs as a tool for managing tourists. The study took place in Australia and allowed tourists to hand-feed wild dolphins located in shallow waters near their resort. Orams' (1997) study resulted in visitors being more educated and engaged in conservation-related behavior and had increased enjoyment overall. Today, outdoor wildlife-based learning in Australia attracts five million visitors annually (Ballantyne and Packer 2006). Sustainable tourism also corresponds directly to informal learning, as it is an effective way of enhancing long-term environmentally conscious habits. Overall, as tourist demands for outdoor experiences increase, outdoor settings can be used as a valuable resource to promote environmental learning (Ballantyne and Packer 2006).

The benefits of informal education are well documented. Informal education helps people develop skills and knowledge explicitly catered to that person's interests (Coombs and Ahmed 1974; McGivney 1999). As a result, these experiences lead to outcomes such as emotional reactions, an introduction to new concepts, and reframing ideas. Informal learning experiences can also positively influence attitudes and behaviors about a subject and enhance emotions (Bell et al. 2009). As a result, through informal education, learners can engage with the environment, observe cause and effect

of environmental mismanagement, and develop their environmental knowledge that can be taken beyond the setting where initial learning occurred (Ballantyne and Packer 2006). Additionally, learners become more heterogeneous (Ballantyne and Packer 2006), and experiences can be transformative (Schugurensky 2000). These benefits run parallel to ones that could potentially occur from informal learning through glacier tourism. For example, those who participate in guided glacier tours can experience a transformative state of mind on a particular topic such as climate change. Also, since glaciers are not heavily incorporated into formal learning settings, guided tours allow for those interested in the subject of glaciers to submerge and expand their. All types of guided tours cab be an outlet for further research on informal and outdoor learning. If informal learning were acknowledged when developing glacier tourism programs, science-based information presented during guided tours could be embedded in tourists' memories, possibly motivating tourists to live more climate-sensitive lifestyles.

2.5.2 Environmental Interpretation

A necessary component of environmental education is how information is communicated and presented within a particular context. Interpretation is often used within nature-based tourism experiences, through both non-formal and informal education efforts. Environmental interpretation has been defined as "an educational activity which aims to reveal meaning and relationships through the use of original objects, by firsthand experiences, and by illustrative media, rather than to communicate factual information (Tilden 1977, 8). According to Knapp (2007), there are three goals for program development in environmental interpretation: entry-level, ownership, and

empowerment. These three goals are outlined in Figure 2.3. This model aims to stimulate positive change in visitor behavior and understanding (Knapp 2007). A similar discussion involved using environmental interpretation to influence visitor behavior can deem itself as an important management tool, which can lead to better behavior among visitors (Orams 1996; Ballantyne and Packer 2006). Furthermore, Orams (1996) emphasized that there are numerous examples of interpretation programs on the natural environment show that they not only help to protect the environment but that they also increase visitor enjoyment (Beckmann 1988; Jelinek 1990; Alcock 1991).

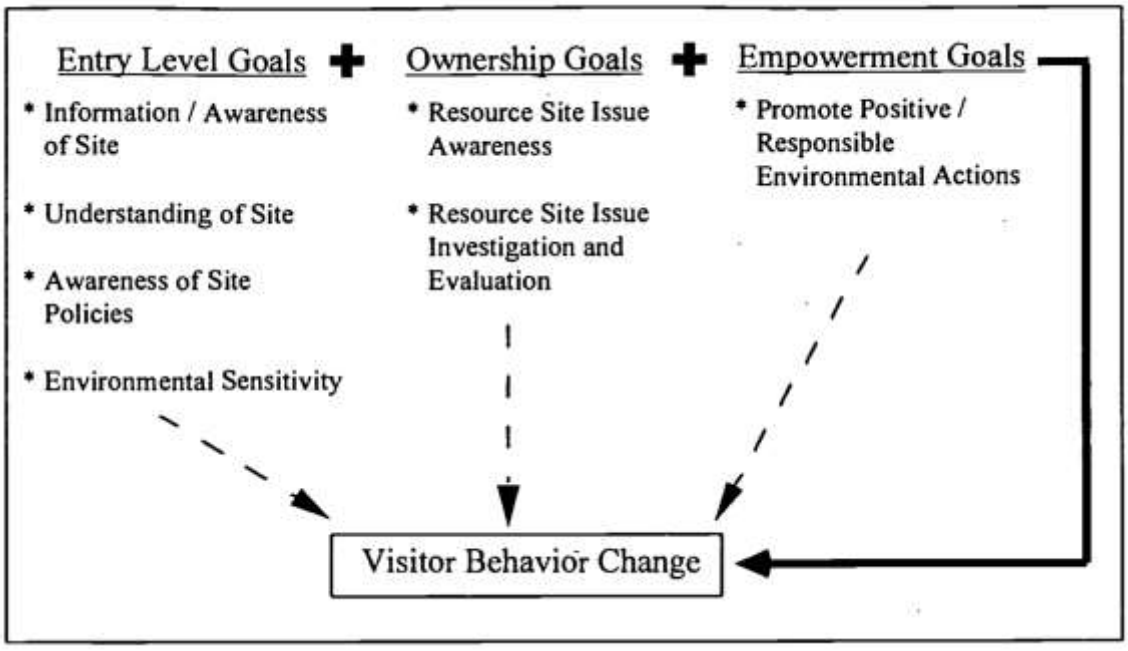


Figure 2.3: Environment Interpretation Behavior Change Model
(Source: Knapp 2007, 56).

Tour guides play a crucial role in adequately informing visitors in informal settings. It has been claimed by Cohen (1985) that tour guides should act as a pathfinder or a mentor. Pathfinders are individuals who are local to the area and have extensive

knowledge of their home environment but lack training. Yet, they can lead individuals that lack orientation within a specific environment. On the other hand, mentors act more as a "spiritual advisor" (Cohen 1985, 8). In the scope of tour interpretation and guided glacier tours, the "pathfinder" deems itself a more relevant approach to effectively inform visitors, promote environmental awareness, and produce mindful and active visitors who may question and reassess the way they view the world (Moscardo 1996; McDonnell 2001). With the prevalence of visible climatic changes of glacier attractions in Iceland (Welling and Árnason 2016), and the increase of last-chance tourism efforts, glacier guides in Iceland play a critical role in informing tourists in ways that are accurate and promote environmental stewardship.

2.6 Conclusion

Tourism, glaciers, and environmental education seem like three unrelated topics, yet, together, they encompass themes that can be combined to form a beneficial comprehensive study. Understanding informal learning experiences in outdoor environments is critical, as these environments allow participants to engage, observe, and develop their environmental knowledge, which has the potential to be remembered for months after their experience (Ballantyne and Packer 2006). Polar tourism and informal learning are both established and expanding throughout published literature, but gaps exist when these two ideas are merged. Additionally, glacier tourism in Iceland has become a developed, well-established industry, yet research on the industry is still overall lacking. A more comprehensive understanding of tourists' perceptions before and after guided glacier tours can help spread awareness and interest in glacial-related

topics, such as glacial vulnerability and processes. Furthermore, by understanding how different glacier experiences can promote understanding of climate change science, perceptions of climate change, and the relationship of glacial change to climate patterns, tour operators can better develop tours that meet both the entertainment and education goals of informal environmental education and sustainable nature-based tourism.

Chapter 3: Study Area

Iceland lies in the north Atlantic Ocean close to the Arctic circle (Björnsson and Pálsson 2008) and has a growing population of roughly 356,000 (Statistics Iceland 2019). Around 64% of Iceland's population lives in the capital city of Reykjavik, while the remainder of the population is scattered throughout the country, mostly within small towns along the coast. The interior land of Iceland primarily consists of vast geologic features such as mountains, glaciers, volcanos, and waterfalls (Ogilvie 2012; Sæþórsdóttir 2017). Referred to as the "land of fire and ice," Iceland is known for its incredible landscapes, which has drawn a lot of international attention in recent years (Sæþórsdóttir 2017); these landscapes offer extensive economic benefits for Iceland through mass fishing, renewable energy, and tourism activities.

3.1 Physical Geography

Iceland is the second largest island in Europe, with a land area of 103,000 km^2 and a coastline of 6,088 km (CBI 2016) (Figure 3.1). Of this land area, 60% lies at an altitude above 400m and 24% lies below 200m (Sæþórsdóttir 2017). Iceland's landmass is situated where the mid-Atlantic Ridge and the Greenland-Iceland Faroe ridge meet (Thordarson 2012). Geologically, the country is young compared to others, with all of the rocks forming within the last 25 million years, and the oldest rocks physically seen on the surface being approximately 15 million years old (Thordarson 2012).

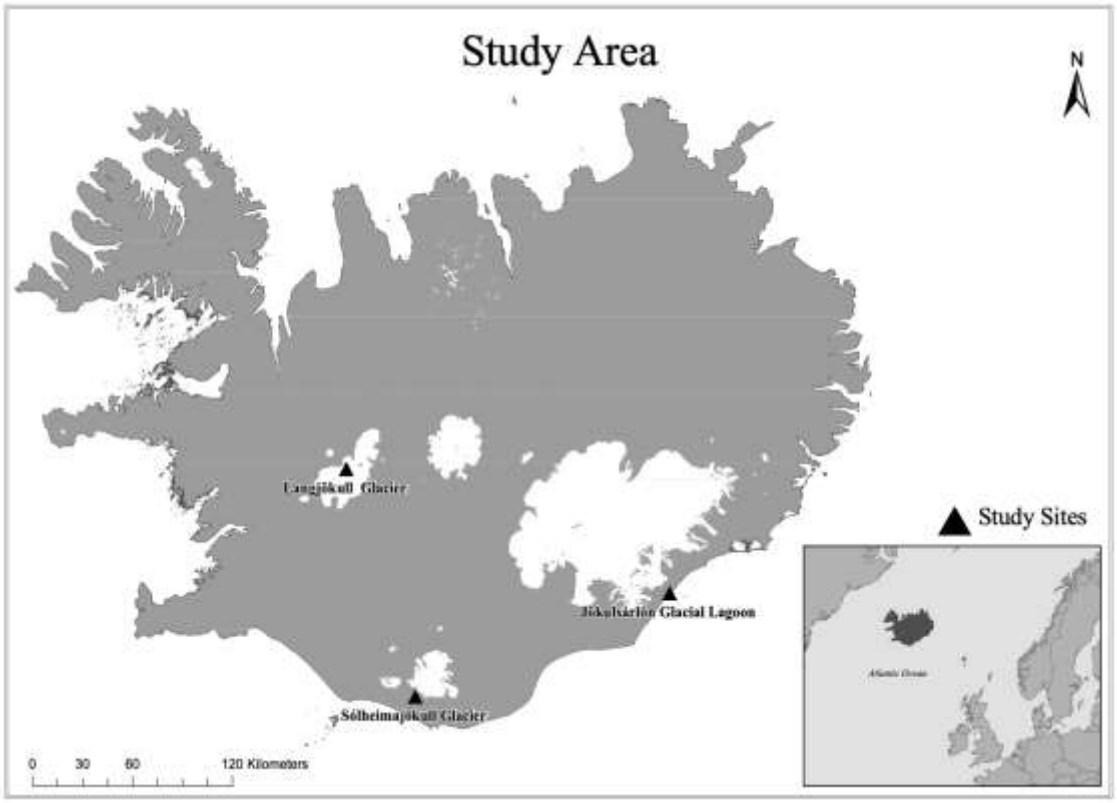


Figure 3.1: Map of Study Sites (Source: Created by author).

Iceland is home to a vast amount of unique geological and geomorphological features, with highland plateau terrain scattered amongst mountains and glaciers, and coastlines consisting of bays and fjords (CIA 2018). One of the most visited features in Iceland is the Mid-Atlantic Ridge since Iceland is one of the few places on earth where part of the ridge rises above sea level and is visible on the surface (Thordarson 2012). In addition to the presence of the Mid-Atlantic Ridge, Iceland is interspersed with a variety of other impressive landforms including powerful waterfalls such as Gullfoss, Geysir (which all existing geysers in the world are named after (Karlsdóttir 2013)), black-sand beaches, volcanoes, lava tubes, and visible geologic occurrences. Icelandic glaciers cover around 11% of the landmass, containing 3,600 km^3 of water; if these glaciers

melted, global sea level would rise by one centimeter (Björnsson and Pálsson 2008). Iceland is volcanically active, with an eruption occurring every three to four years (Gudmundsson et al. 2010). Additionally, due to its geologic placement, consistent subglacial eruptions and jökulhlaups occur in Iceland, each varying in intensity (Gumundsson 2005). Collectively, these features create an incredible landscape with consistent popularity.

3.1.1 Climatic Influences

Iceland is located at 63°-67° N and 18°-23° W, yet its climate is much milder than the location would imply. This mild climate results in little variation between seasonal temperatures (Björnsson 2017). The temperature can be classified as temperate maritime, meaning it is heavily reflective of the surrounding cool ocean waters (Ingólfsson 2008). The climate of Iceland is also influenced by its position in the middle of the North Atlantic, where both cold and mild temperatures and air currents meet (Ogilvie 2012). Within the Köppen classification system, Iceland falls in two climatic systems; the southwestern region of Iceland sees a temperate, rainy climate with cool, short summers (Cfc), while northern Iceland and the highlands experience an 'ET' classification consisting of snowy, polar climate patterns (Einarsson 1984). The lowest average winter temperatures near the southern coasts range from 0℃ to 11℃, with a mean annual temperature of only 5℃ (Björnsson and Pálsson 2008). Arctic sea ice, also known as drift ice, brought in by the East Greenland current, can act as a heat sink, which lowers the temperature on land, results in crop failures, and blocks harbors (Ogilvie 2012).

Both rain and wind are common occurrences throughout Iceland. Most of Iceland's precipitation patterns reflect the atmospheric low-pressure cyclone passages across the North Atlantic, causing heavy precipitation in the country's southern coast. Wind direction and speed are mostly influenced by topography and altitude, with the harshest wind occurring in the highlands (Ingólfsson 2008). Additionally, snow accumulated in these higher altitude regions results in the development of glaciers (Björnsson and Pálsson 2008).

3.1.2 Glaciers

One of the most well-known geologic features and attractions of Iceland are dynamic glaciers. A glacier can be classified as a large body of ice created from snow, which has annually collected above the snowline, eventually transforming into ice after being buried deeper and deeper (USGS 2016; Björnsson 2017). While all glaciers are created from ice, both the development and behavior of a glacier can differ depending on how much snow the glacier accumulates, ice hardness, meltwater rate, and overall movement; in addition, the existence of glaciers is determined by climate, transport of moisture and warmth, location, and movement of the Earth's crust (Björnsson 2017). There are various types of glaciers: ice sheets, outlet glaciers, and ice shelves (Table 3.1), each consisting of different geomorphological sizes and features (USGS 2013). Iceland is home to an abundance of glacier types; for example, Vatnajökull, Iceland's largest glacier, is a common example of an ice sheet, while Sólheimajökull is considered an outlet glacier. The calved pieces from Breiðamerkurjökull that end up in Jökulsárlón are examples of ice shelves.

Table 3.1: Glacier types. Modified from Björnsson (2017, 8-9).

Glacier Type	Subcategories
Ice Sheet: Moves in all directions	Continental Glaciers: Largest ice sheets seen today (e.g., Greenland or Antarctica) Ice Caps: Smaller and thinner than continental; main ice masses in Iceland
Outlet Glaciers: Moves in one direction, determined from landscape	Piedmont Glaciers: Spread out like fans once in lowland plains Valley Glaciers: Found in valleys Valley-Head Glaciers: Limited to head of a valley Cirques: Found in rounded valley hollows Hanging Glaciers: Found in hanging valleys Ice Aprons: Ice carapaces on mountain sides Mixed Glaciers: Glacier tracts within the highlands
Ice Shelves: Part of glacier floating on body of water, calving at margins	No subcategory

Glaciers contain the largest reservoir of freshwater on Earth and are useful tools in determining climatic changes throughout history (Björnsson 2017). Icelandic glaciers, in particular, receive over 20% of the precipitation that falls on the country. As a result, Icelandic glaciers store an equivalent of 15-20 years of precipitation as ice (Jóhannesson et al. 2006). These glaciers respond very quickly to climatic changes and are long-term reservoirs of ice that becomes meltwater and eventually flows into the rivers which traverse the country (Aðalgeirsdóttir et al. 2006). These rivers are used to produce

hydroelectric power throughout Iceland (USGS 2016; Björnsson 2017). Due to their vulnerability and the influence they have on the surrounding environment, Icelandic glaciers are regularly used for research related to glacio-volcanic activity, meltwater rates and quantity, and changing climatic conditions (Björnsson 2017).

In more recent years, glaciers have also become prime visiting locations for tourists. Of tourists visiting Iceland in 2018, 92.4% stated that the natural environment was the reason they chose to visit the country on a survey distributed to outgoing visitors; of this percentage, 17% specifically stated that glaciers attracted them the most (Óladóttir 2018). Various companies in Iceland, such as Extreme Iceland, Guide to Iceland, and Into the Glacier excursions, offer guided tours on or near a number of Icelandic glaciers; the most accessible and popular of these sites include Vatnajökull, Sólheimajökull, Jökulsárlón, and Skaftafell.

3.2 Cultural Geography

While the geologic features in Iceland are at the forefront of the country's wonders, its cultural history is also important in regard to its socio-economic development. Iceland was settled in 9th century CE by people of mainly Norse or Celtic origin in the wake of the Viking expansion westward (Ogilvie 2012). Iceland officially became an independent country and a self-governing republic in 1944 (CBI 2016). Currently, around 80.5% of the original male population is of Norwegian origin, while 62.5% of the female population came from the Northern British Isles (Ogilvie 2012). The Evangelical Lutheran Church of Iceland is considered the official religion, but over a quarter of the country practices other religion types (CIA 2018). Iceland's cultural

history is a large part of why visitors go to Iceland, as it is a country with many medieval treasures and interesting sagas (Karlsdóttir 2013). The Icelandic Tourism Board determined that approximately 54% of tourists in 2018 stated Icelandic culture was their motive to travel (Óladóttir 2018).

3.2.1 Economic Influences

In recent years, Iceland has witnessed significant success regarding its economy and is currently one of the most wealthy and well-developed countries, but that was not always the case (Ogilvie 2012). In 2008, three of Iceland's banks suffered from liquidity problems and were absorbed into government administration. Due to this, the Icelandic krona depreciated, which created a financial crisis. With a quick recovery, the economy has grown significantly, and Iceland now experiences low unemployment, higher economic growth, and a more even distribution of income (CIA 2018). In other respects, Iceland has become a modern welfare state, giving its citizens access to universal health care, education, and high degree social security (CBI 2016).

The economic growth seen in Iceland is a result of the success of the three main economic sectors: fishing, manufacturing, and tourism. The fishing industry was the primary source of economic growth during the second half of the 20th century (CIA 2018). More recently, tourism has become the main economic driver for the country. In both cultural and geological aspects, Iceland has come to deem itself as an extremely sustainable country by taking advantage of its geological properties through its use of renewable energy sources. Overall, hydroelectric and geothermal power sources provide around 70% of the country's overall energy use, with geothermal sources heating

approximately 90% of the homes in Iceland and being a crucial part of Iceland's economic development (Ogilvie 2012; Thordarson 2012).

3.2.2 Tourism in Iceland

While tourism was not always the main source of income in Iceland, the industry has grown exponentially in recent years, establishing itself as a crucial economic earner (CBI 2016; Óladóttir 2018). International travelers began visiting Iceland in the late nineteenth century (Jóhannesson et al. 2010). In 2010, one of southern Iceland's ice-capped volcanoes, Eyjafjallajökull, erupted, leading to significant international attention to the area as the eruption disrupted air traffic from ash plume, ice melt, and flooding (British Geological Society 2017). The Eyjafjallajökull eruption resulted in a 15.8% increase in visitors to Iceland between the 2010-2011 seasons (Óladóttir 2012). The increase in tourism activity between 2010-2011 resulted from overall excitement and sudden interest to visit, combined with Iceland's attempt to heavily promote the tourism industry in order to rid any thought of harmful or intense natural disasters. Specifically, as part of the tourism campaign, *Inspired by Iceland*, the government invested 350 million ISK, the equivalent of nearly 2.4 million USD, into social media, marketing, and celebrity endorsement to convince visitors that Iceland is a safe environment (Benediktsson et al. 2011). The number of foreign visitors to Iceland almost quadrupled between 2010 and 2018 (Óladóttir 2018). As a result of the exponential growth of international visitors, tourism has produced an abundance of economic and employment benefits for Iceland. For example, between 2013 and 2018, the annual increase of employees in the tourism industry increased by 68% as the demand for hotel

accommodations, dining services, and operating services has increased with the number of individuals traveling to Iceland (Óladóttir 2018). More recently, tourism numbers have decreased, with a 23.1% decrease in visitors between May 2019 and April 2020 (Óladóttir 2020).

3.3 Study Sites

This research focused on three distinct tourist destinations and activities within Iceland: Sólheimajökull glacier hikes, 'Into the Glacier' excursions at Langjökull, and Jökulsárlón boat tours. These study sites were chosen for three primary reasons: their popularity among Iceland visitors, diversity of glacier-related features and tourism experience, and established tourism management procedures. Specifically, each of these locations receives a large number of visitors annually, the various activities offered at each of these study sites differ from one another allowing for investigation of a multitude of glacier tourism activities, and these sites have well-developed management and qualified operators guiding and educating visitors, which allowed them to be easily studied through the methods used.

3.3.1 Sólheimajökull

Located in southern Iceland, Sólheimajökull, an example of an outlet glacier, is 15 km long and around 44 km^2 wide. Sólheimajökull flows south of the Mýrdalsjökull, which is the fourth largest ice cap in Iceland, covering 596 km^2 of land surface (Friis 2011). Mýrdalsjökull is unique because its ice cap covers a large portion of the Katla volcano caldera, one of the most active and dangerous volcanoes in Iceland. Due to this,

many subglacial eruptions from Katla have led to a variety of jökulhlaups on Sólheimajökull, causing destruction to the nearby landscape and resulting in its quick response to climatic variability (Friis 2011).

Sólheimajökull (Figure 3.2) was a necessary site for this study because multiple tourism companies operate tours on this glacier, and it also receives a significant number of visitors not on guided tours; this allows for a valuable opportunity to evaluate a large and diverse range of tourist perspectives. Additionally, this glacier has been the forefront of many studies and research involving climate change (Friis 2011). Sólheimajökull was also featured in a successful documentary, *Chasing Ice*, which starred National Geographic photographer, James Balog, through his journey documenting glacier retreat around the globe (Orlowski 2012). Documentaries such as this one produce quite a bit of popularity amongst viewers, increasing the urge to visit these locations and physically see these glaciers.

A variety of tours take place on and around the Sólheimajökull. Various tour operators offer different experiences dependent on tourists' interests. Icelandic Mountain Guide, specifically, has tours ranging from snowmobile rides, northern light viewings, ice-caving, or kayaking. Of the most popular tours, the Sólheimajökull glacier walk is on top of the list. Tours can last all day or around two hours, depending on personal preference. The short, two-hour hike is available all year round and is beginner-friendly with a group size up to 15-25 people per guide (an additional guide will help lead the tour if a group exceeds 15 people). All participants are provided necessary gear such as crampons. An experienced glacier guide will lead visitors along the glacier and shares

information on Iceland's changing glaciers and their connection to surrounding geologic features (Icelandic Mountain Guide 2019).

Figure 3.2: Sólheimajökull Glacier (Source: Photo courtesy of Dr. Leslie North).

3.3.2 Langjökull

Langjökull is Iceland's second largest glacier, having a surface area of 870 km^2 and an ice volume of 207 km^3. Its name, derived from its length, translates to 'long glacier' (Björnsson 2017; Into the Glacier 2018). Icelandic natives usually associate this glacier with its ancient sagas about trolls and outlaws. Geologically, Langjökull has a variety of different visible features with outlet glaciers and runoff draining in all directions. Additionally, it consists of mountain pinnacles, glacial lakes, and occasional vegetated areas.

Into the Glacier is a more recent glacier tourism operation in Iceland which offers a unique experience for visitors. Into the Glacier takes tourists across Langjökull glacier and into a human-made ice cave, allowing for guests to physically see the inside

of a glacier. The idea for this experience arose in 2010 when Baldvin Einarsson and Hallgrimur Örn Arngrímsson had the vision of taking people literally inside the glacier in order to see the incredible “blue ice” and other features not accessible on the surface. After careful planning and gathering expertise of engineers and geophysicist, the operation came to life and soon was considered the first and biggest human-made ice cave (Into the Glacier 2018). Into the Glacier tours last around 3-4 hours in length. The tour begins by riding up the ice cap in a modified glacier vehicle and stepping out on top of the glacier itself. Tourists are provided crampons upon entering the manmade cave, and tour guides lead visitors throughout the cave, explaining basic glacier facts (Into the Glacier 2018). Unlike most tours, Into the Glacier offers an experience unavailable anywhere else in the country. Therefore, this unique, one-of-a-kind experience is the core reason this site was chosen for this study.

Figure 3.3: Into the Glacier: Ice Cave (Source: Photo courtesy of JT Troxell).

3.3.3 Jökulsárlón

Jökulsárlón is a naturally formed glacial lagoon located along the bottom of the Breiðamerkurjökull outlet glacier of the Vatnajökull ice cap. Breiðamerkurjökull is the fourth largest outlet glacier located on this ice cap. Jökulsárlón (Figure 3.4) is continuously expanding due to the extensive amount of calved ice falling into the water (Guðmundsson et al. 2017). Formed in the early 1930s from the Breiðamerkurjökull retreat, Jökulsárlón is considered Iceland's deepest lake, with a depth of 248 meters. The lagoon is famous for its vivid blue color, which is caused from a mixture of freshwater and nearby saltwater from the connecting ocean (Gunnarsdóttir 2017). Directly across from Jökulsárlón is the Black Diamond Beach, where diamond-like pieces of ice lay

ashore before drifting into the North Atlantic. Overall, Jökulsárlón and its surrounding area is an aesthetic spot to visit for tourists and photographers.

Figure 3.4: Jökulsárlón Glacial Lagoon (Source: Photo by author).

Jökulsárlón was chosen as a study site because it offers another perspective for viewing and understanding climate change effects through a unique glacier-related experience. Specifically, boat tours on the lagoon are offered during the summer months, with around 40 trips operating throughout the day (Gunnarsdóttir 2017). The Glacier Lagoon tourism company offers two types of tours on different types of boats: Amphibian and Zodiac. The Amphibian boat tour is 30-40 minutes in length. During the tour, a multi-lingual guide leads tourists around the icebergs and scenery of Jökulsárlón,

describing the unique geology and various facts about the location. Tours are usually delivered in English, but guides are required to speak multiple languages, as many international tourists visit daily. During the high tourist season (July-August), around 40 trips are guided per day. In other months, the company runs roughly 15 trips each day, depending on the weather. The Zodiac boat tour is similar, but lasts approximately one hour, and takes visitors as close to the glacier as possible, offering an in-depth, more personal presentation on the site. The Zodiac tour operates from June until the end of October and departs six times a day (Glacier Lagoon 2019). Each tour offers the opportunity to see the icebergs up close and witness wildlife within the area. These boat tours on Jökulsárlón are another unique one-of-a-kind experience not regularly available or accessible in other parts of the world, making them great for the study of the outcomes and applicability of informal environmental education delivered through nature-based tourism experiences to teach tourist about climate change and glaciers.

Chapter 4: Methodology

According to Maxwell (2005), qualitative research has five goals: understanding the meaning, understanding the context in which participants act, identifying an unanticipated phenomenon and generating new theories, understanding processes in which events take place, and developing casual explanations. This research used a mixed-methods approach to create a comprehensive understanding of tourist perspectives during guided glacier tour experiences in Iceland. Specifically, this research assessed the outcomes and applicability of environmental education to teach about climate change during guided glacier tour experiences and how different tour experiences may influence a visitor's understanding and perception of climate change after a tour is completed.

Data were collected in Iceland between October 2nd and October 11th, 2019. Approval to conduct research with human subjects was obtained from the Western Kentucky University Human Subjects Institutional Review Board (IRB). Additionally, consent to distribute surveys to their customers was obtained from each tourism company operating at each study site. Data collection occurred at three well-known tourism operations in Iceland: Sólheimajökull glacier hikes, Into the Glacier human-made ice cave excursions, and Jökulsárlón boat tours. At Sólheimajökull, multiple tourism companies allowed the research team to distribute surveys to their tour groups; only one company operates guided tours at the Into the Glacier and Jökulsárlón.

At each of the study sites, three methodological approaches were used: pre- and post-outcome assessments, semi-structured interviews, and recorded observations (Figure 4.1). Survey assessments were distributed to visitors in order to understand and

evaluate changes in tourist perceptions before and after guided glacier tours. Semi-structured interviews took place with glacier guides to gain better insight into their personal challenges and perspectives of tourist attitudes and behavior, as well as knowledge of climate change impacts. Semi-structured interviews were collected with two researchers present, one to take notes and one to ask pre-determined questions.

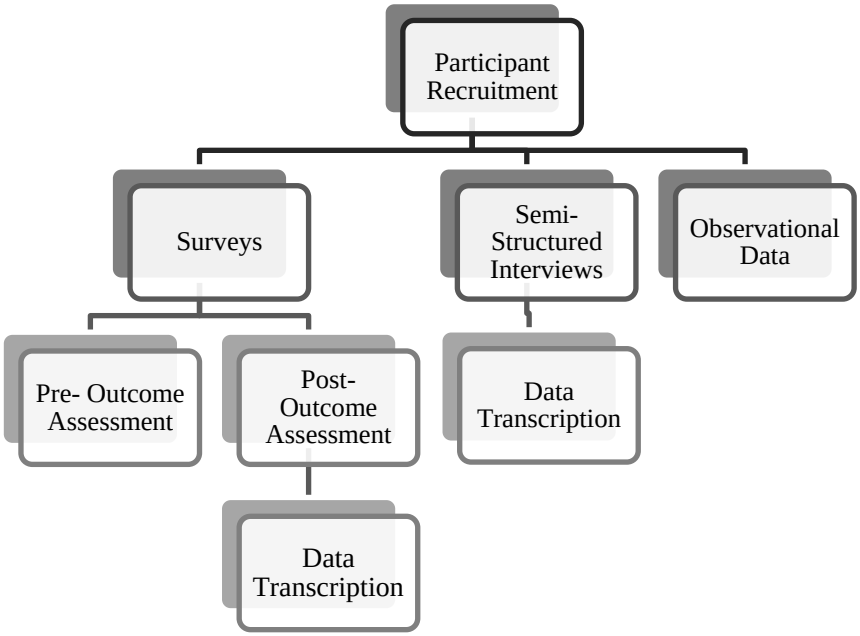


Figure 4.1: Flow chart of data collection process (Source: Created by author).

4.1 Participant Recruitment

For pre- and post-outcome assessments, groups of English-speaking adults (age 18 or older) with varying demographic characteristics were recruited to participate. Only English-speaking adults were chosen because the researcher did not have access to a translator during time of data collection. Recruitment took place before the tour with individuals after tour tickets were purchased. All ticketed guests at each of the three

study sites were asked to participate in the study since tour group sizes were often less than twenty people. With this research project, it was not possible to pre-screen or select participants ahead of time. Any individual willing to consider participation in the study received a brief explanation of the research, and then was presented with necessary IRB consent documents (Figure 4.2). All individuals choosing to participate in the research were allotted enough time to complete the assessments without disrupting the tour schedule or their experience.

Figure 4.2: Photograph of researcher and research assistant recruiting tourists to participate in pre- and post-outcome assessments. Faces have been blurred for confidentiality (Source: Photo courtesy of Dr. Leslie North).

Semi-structured interviews took place with glacier guides operating tours at each study site. Guides were approached and identified on-site during each day of data collection (Figure 4.3). Tour operators were contacted before travel to Iceland

commenced and approved the research team being on-site for data collection. The researcher also approached employees working at each facility during the time of data collection to ensure permission remained granted. Often, they would assist in gathering guides to be interviewed.

Figure 4.3: Photograph of researcher and research assistant, interviewing a glacier guide at Sólheimajökull glacier. Face of participants has been blurred for confidentiality (Source: Photo courtesy of Dr. Leslie North).

4.2 Data Collection

As previously stated, research collection took place between October 2nd - October 11th, 2019, with the researcher, research assistant, and a representative from Western Kentucky University. Inclement weather resulted in tour cancellations and

prevented data from being collected on two days of the research expedition. On occasion, the research team would travel between Sólheimajökull and Jökulsárlón, depending on tour activity during a given research day. In total, the research team spent three days at Sólheimajökull and Jökulsárlón, each, and one full day at Into the Glacier collecting outcomes assessment and guide interview data.

4.2.1 Pre- and Post-Outcome Assessments

Each assessment instrument consisted of five to seven questions in order for tourists to quickly take the assessment without interfering with their guided tour. Assessment questions were developed through the use of short-answers, circle-all-that-apply, and the 5-point Likert-scale. The 5-point Likert-scale question tool was created by Rensis Likert (1932) to establish a procedure for measuring attitudinal scales and quantitatively analyzing qualitative data. This research utilized this method to analyze and compare participant responses between tour types accurately. Before data collection occurred, the assessment instrument went through a validation process. Based on the developed research questions, the researcher put together a series of questions and phrases that would contribute to significant results. After questions were drafted, the researcher sent the questionnaire to colleagues, family, and friends for feedback. The reviews of the instrument questions were instructed to interpret the questions, so the researcher could glean if the interpretation of the question and the information being sought was as the researcher intended. This process also ensured that bias was not introduced into the dataset by ‘leading’ questions and that individuals of all demographic backgrounds could equally understand the assessment questions.

At Sólheimajökull and Jökulsárlón, after signing the IRB-approved informed consent document, participants were given a pre-assessment before the guided glacier tour. Assessments were distributed on a clipboard with a writing utensil provided (Figure 4.4). After completing a guided tour, the same individuals received the post-assessment, containing similar questions in order to determine the amount of information gained while on the tour. Each participant was assigned a unique identifier by the research team, such as a symbol or the color shirt a visitor was wearing, in order to match the pre- and post-assessments, but still maintain their confidentiality. This method of pre- and post- assessment data collection was not possible at Into the Glacier.

Figure 4.4: Photograph of researcher and research assistant preparing to distribute post-assessments at Sólheimajökull glacier. Face of participants has been blurred for confidentiality (Source: Photo courtesy of Dr. Leslie North).

At Into the Glacier, the research team had to present tourists with both the pre- and post-outcomes assessments following their guided tour. Tour groups quickly departed for their tour once arriving to the Klaki base camp; therefore, it was not possible to distribute pre-assessments in a timely manner. Due to this, the researcher assured that tourists understood and considered the first page of the assessment as their perceptions prior to the guided tour, and the second page as perceptions afterward. In addition, questions were worded in such a way that made it clear of this distinction. For example, the pre-assessment asks, "do you think your knowledge on climate change will broaden after going on this tour," while the post-assessment states "my knowledge on climate change increased after embarking on this tour."

4.2.2 Semi-Structured Interviews

In addition to pre- and post-outcomes assessments, semi-structured interviews took place with glacier guides in order to collect qualitative data on their observations of tourist perspectives and understanding. The researcher conducted interviews with glacier guides on-site during each day of data collection. Similar to pre- and post-outcomes assessments, an IRB informed consent document was provided prior to the interview beginning. All interviews utilized a basic script with pre-determined questions (see Appendix C), with additional questions asked as the interview evolved. The use of semi-structured, open-ended questions amongst each interview encourages depth and allows new concepts and conversations to emerge (Dearnley 2005). Each interview ended with a series of demographic questions. On average, interviews lasted 15-20 minutes,

depending on the flow of the individual interview. During the interview, the researcher and assistant took brief notes of time, date, and important points mentioned.

4.2.3 Observational Data

During each guided tour at the three study sites, observations were made regarding the information presented and overall tourist behavior. In addition to assessment and interview responses, it is important to know what exact information guides were sharing during the tour, and if this information is more scientific, cultural, or entertaining. Qualitative methods in research, such as recording observations, are conducted in order to develop an in-depth analysis of various aspects of the social world and to understand individuals' social experiences and perspectives (Ritchie et al. 2013). Observational notes consisted of physical observations (weather, geography, number of tourists per tour) and key points presented during the tour. At the end of each day, observational notes were reread and electronically transcribed. All transcriptions were electronically stored on a flash drive, password-protected folder, and a secure online storage drive.

4.3 Data Analysis

All interviews were recorded with a voice recorder and later transcribed in order to analyze the thoughts and themes stated throughout. Transcription occurred in Microsoft Word, through listening, interpreting, and noting all aspects of the recording, including tone and background noises. Following transcriptions, all interview notes were read through twice to ensure no mistakes were included. Corresponding notes taken

during the interview were analyzed and included in the final transcription. At the end of each research day, interview recordings were saved on a flash drive, in a password-protected folder, and a secure online storage drive.

Interview transcriptions and observational data were analyzed for specific themes through coding. Coding is done by marking specific segments of text with an identifying characteristic such as symbols, words, or names (Johnson and Christensen 2008). Coding may be done through computer software; yet, coding by hand allows the researcher to incorporate further aspects into the analysis, such as noted observational data (Basit 2003). Chosen interview codes were analyzed twice, analyzing thematic codes separately, then as a whole group. More specifically, themes and subthemes were developed through common responses among interviews (Table 4.1). The frequency of dominant themes was entered and calculated in Microsoft Excel. Coding allowed the researcher to organize responses in ways that directly answer the research questions of this study. Coding breakdown is displayed in Appendix F. Codes were selected based on conversations and common trends among interviews. For example, a guide at Sólheimajökull stated that their path to the glacier is continually changing. Common statements were made among all sites, resulting in the coding theme “environmental challenges.”

Table 4.1: Coding Themes and Subthemes (Source: Created by author).

Theme	Subtheme
Qualifications	-Speak 1+ Language -Training Courses
Background Knowledge	-No previous knowledge -Growing up in Iceland -School -Previous Tourism Job
Knowledge Gained	-Almost everything I know -How glaciers work -Glacial Retreat
Environmental Challenges	-Glacier Retreat -Access -Daily Challenges -Seasonal Challenges -Size of tour groups -Timing
Take Away Message	-Understanding glacial retreat and advance -Global warming impact -Learn something and have fun -To respect nature
Tourist Knowledge	-Mixed understanding; some who have no idea, others who know a little -Don't know what a glacier is -Only there for photos
Importance of Informing Tourists	-Not crucial; could include a little (it is their vacation) -Important -Should emphasize climate change more
Changes in Tourism	-Increased Visitors -Increase in glacier tourism -Change in demographics -Tourist awareness -Structure of tourism -Decreased visitors

Assessment responses were used to analyze and compare changes in regard to perspectives about glaciers and climate change before and after a tour; see Appendices A and B for the assessment instrument used. All pre- and post-assessment responses were analyzed in Excel to determine the frequency of responses and then converted to percentages to emphasize findings, and later graphed to give a visual representation of results. Any open-ended questions were read through thoroughly and noted for any reoccurring themes. These were analyzed with standard methods of coding; all responses were read once and then again to be coded by hand to develop themes.

Demographic information from both assessment and interviews was entered into two separate Microsoft Excel sheets. This helped better organize age, educational level, country of origin, and gender of participants, developing a cultural representation of participants involved in the study. Transcribed notes from both observations and interviews were reread and coded to establish themes that correspond with assessment responses. Once both assessments and interviews were fully interpreted and transcribed, the researcher analyzed results for any trends between assessment results and information gained during interviews. Comparisons of the outcomes were made amongst all three tour types: guided surface glacier hike, glacier lagoon boat tour, and tour inside a glacier.

4.4 Limitations

This research aimed to produce methods that answered the research questions and provided a wide array of results. The planned recruitment process led to a variety of limitations. For example, participant recruitment only involved English speaking adults.

Considering Iceland receives a diverse number of tourists, with nearly two million visitors of varying nationality in 2019 (Óladóttir 2020), there were occasions when some non-English speaking tourists were also on the tour; yet, since tours are given in English, most were familiar with the English language and could interpret the assessments. To mitigate this problem, the researcher developed questionnaires that were easy to understand and answer and clearly communicated the overall intent of the project. Those still uncomfortable with the assessment instrument could back out at any moment with no penalty. During such occurrences, the assessment was destroyed and not included in the final data analysis.

Additionally, all participants were voluntary, and there was no specific sampling strategy; thus, volunteer bias could have occurred (Salkind 2010). Rosenthal (1965) stated that those who volunteer tend to have characteristics such as being unconventional, less authoritarian, and have a greater need for social approval; however, volunteers may enhance results because they encompass higher intellectual ability, interest, and motivation towards the research, thus providing more comprehensive data sets to researchers. To mitigate this potential issue, the researcher and research team asked every individual waiting for this tour if they would be willing to participate in order to receive as much input as possible.

Lastly, the researcher was only able to attend and record the Jökulsárlón boat tour. This was mostly due to inclement weather, which had caused many tours to be cancelled at both Sólheimajökull and Jökulsárlón, forcing the research team to rearrange the planned schedule and limit the amount of time they spent at each site. Poor weather conditions, particularly wind, also prevented the researcher from being able to hear

recorded tours, which were recorded on devices placed in pockets under multiple layers of clothing. Despite these limitations, interview themes and resources, such as a guide booklet, gave the researcher a good foundation for the information that would have been presented during the tour.

Chapter 5: Results and Discussion

The purpose of this research was to develop a comprehensive understanding of tourist perspectives on the topics of climate change and glaciers to evaluate any change in perceptions before and after a guided glacier tour experience in Iceland. Specifically, this study assessed both the outcomes and applicability of informal environmental education delivered through nature-based tourism experiences to teach about climate change and glaciers; it also determined how the type of glacier tourism activity influences perceptions of these subject matters. This research utilized a mixed-methods approach of pre- and post-outcome assessments distributed to tourist and semi-structured interviews conducted with tour guides to evaluate these perspectives. To answer the research questions, tourist responses to pre- and post-outcome assessments were compared across three different glacier tour experiences in Iceland: Sólheimajökull glacier hikes, Jökulsárlón boat tours, and Into the Glacier ice cave excursions. Results were used to determine how science interpreters can include environmental topics within existing glacier-related guided tours to improve climate change comprehension.

5.1 Sample Characteristics

5.1.1 Semi-Structured Interviews

During data collection, glacier guides were approached on-site for a short, semi-structured interview, which was recorded and later transcribed. Among the three study sites, 14 semi-structured interviews took place, nine of which occurred at Sólheimajökull due to accessibility to multiple guides. Three interviews took place at Into the Glacier, and two occurred at Jökulsárlón. In total, nine of the interviewed guides

were Icelandic, while others traveled to Iceland from other countries for their guiding job. Of the guides interviewed, 11 were male, and three were female. Of the three females interviewed, two worked at Sólheimajökull, while the other worked at Jökulsárlón. Age range varied among guides, with most being between the ages 25-34 and 35-44. The highest level of education also varied among the interviewed guides, with six of the interviewed guides among the three sites holding a master's degree. Table 5.1 displays full demographic details collected from glacier guides among the three study sites.

Table 5.1: Interviewee demographic details (Source: Created by author).

Age	Gender	Country	Education Level	Tour
35-44	M	Iceland	Bachelor's	Sólheimajökull
55-64	M	Iceland	Technical School	Sólheimajökull
25-34	M	Australia	Bachelor's	Sólheimajökull
35-44	F	Poland	Master's	Sólheimajökull
25-34	M	Iceland	Adventure Guide Certificate	Sólheimajökull
35-44	F	Hungary	Master's	Sólheimajökull
18-24	M	Iceland	Bachelor's	Sólheimajökull
35-44	M	Poland	Master's	Sólheimajökull
18-24	M	Iceland	High School	Sólheimajökull
25-34	M	Iceland	Master's	Into the Glacier
35-44	M	Iceland	Master's	Into the Glacier
25-34	M	Iceland	Technical School	Into the Glacier
18-24	F	Iceland	High School	Jökulsárlón
25-34	M	Belgium	Master's	Jökulsárlón

5.1.2 Pre- and Post-Outcome Assessments

Altogether, 263 tourists completed both the pre- and post-assessments. The highest amount of assessment collection occurred at Jökulsárlón, with 94 fully completed assessments gathered, while 90 assessments were collected from tourists at Into the Glacier and 79 tourists at Sólheimajökull completed the survey. Occasionally, participants completed the pre-assessment, but declined or forgot to take the post-assessment. Assessments that did not have both sides completed were analyzed in a separate Excel spreadsheet and were not included in the final analysis counts of assessment outcomes; results from participants that completed only pre-assessments are discussed and considered when assessing outcomes. Table 5.2 presents the full assessment distribution amongst each site.

Table 5.2: Total Collection of pre- and post-outcome assessments at each study site (Source: Created by author).

	Sólheimajökull	Into the Glacier	Jökulsárlón	**Total**
Participants that completed **both** pre- and post-assessments	79	90	94	**263**
Participants that completed **only the pre**-assessment	16	5	35	56
Participants that completed **only the post**-assessment	3	0	1	4
Semi-Structured Interviews	9	3	2	14

Tourists were recruited before each scheduled tour throughout the day and given an assessment before and after completing their guided glacier experience. A summary

of age and gender distribution of sampled tourist is displayed in Table 5.3. Appendix D shows the full demographic details transcribed from assessment responses, including respondents' highest level of education. Across all sites, the majority of individuals who completed assessments were between the ages of 25 and 34; yet, a variety of age demographics were represented in assessment responses, creating a diverse sample. For example, 11 participants at Jökulsárlón were within the youngest age range of 18-24, while an additional eleven were above 65. In contrast, zero individuals above the age of 65 attended the Sólheimajökull glacier hike; yet, 32 of their visitors were between ages 25-34. Into the Glacier had the broadest range of ages represented in the sample. Among all sites, 94 respondents were male, while 121 were female; 46 assessment participants chose not to disclose their gender. At Sólheimajökull, 40 participants were female, and 26 were male. Comparatively, 28 males and 42 females completed assessments at Jökulsárlón. At Into the Glacier, gender distribution was fairly even, as 40 respondents were males and 39 were female. Sampled tourists had a wide array of education levels; Appendix D summarizes the respondent's answer when asked to report his or her highest level of education.

Table. 5.3: Summary of sampled tourist age and gender distribution (Source: Created by author).

Age	**Sólheimajökull** (n = 79)	**Into the Glacier** (n= 90)	**Jökulsárlón** (n= 94)
18-24	1	2	11
25-34	32	26	28
35-44	9	19	10
45-54	7	13	6
55-64	2	13	0
65+	0	5	11
N.A.	14	12	24
Gender			
M	26	40	28
F	40	39	42
N.A.	12	10	24

Tourists on-site the days of the data collection came from multiple countries. In total, 30 different countries were represented among the three study sites (Table 5.4). Additional countries may be represented, but some tourists chose not to disclose their country of origin. In this case, the researcher denoted “N.A.” on that part of the assessment. The highest number of participants among all sites were from the United States and the United Kingdom; yet, countries such as South Africa, Peru, Australia, Spain, and Romania were also represented. Jökulsárlón experienced the most demographic differences with regard to country of origin, with visitors from 22 various countries represented in the sample. Seventeen countries were represented at Into the Glacier, including Lithuania, Peru, Portugal, and Slovakia. In addition, 16 different countries of origin are represented in the Sólheimajökull data set, including Poland, Denmark, Belgium, and Singapore.

Table. 5.4: Tourist country-of-origin distribution summary amongst each study site (Source: Created by author).

Country	Sólheimajökull	Into the Glacier	Jökulsárlón
Australia	4	3	-
Belgium	1	-	-
Canada	-	5	-
China	-	3	4
Colombia	-	-	2
Denmark	1	-	-
France	1	2	7
Germany	1	3	1
Gibraltar	2	-	-
Hong Kong	2	10	2
India	-	-	2
Israel	3	-	1
Italy	-	-	1
Lithuania	-	1	-
Mexico	-	-	2
Netherlands	-	4	2
New Zealand	-	-	1
Peru	-	1	-
Philippines	-	-	1
Poland	4	-	3
Portugal	-	2	-
Romania	-	-	4
Russia	-	-	2
Singapore	1	-	1
Slovakia	-	2	-
South Africa	1	4	2
Spain	4	6	1
Taiwan	3	5	3
United Kingdom	4	6	2
United States	32	7	26
N.A.	12	13	23

5.2 Sólheimajökull

Sólheimajökull is an outlet glacier located in southern Iceland. Sólheimajökull flows south of the Mýrdalsjökull, the fourth largest ice cap in Iceland (Friis 2011). It is one of the most researched glaciers in Iceland and is at the forefront of many climate

change studies. Due to this popularity, many tourists visit Sólheimajökull annually. Tour companies that operate on Sólheimajökull offer glacier hikes, ice climbing, and exploration of ice caves. This research focused specifically on 'basic' glacier hikes. Tourists who book a basic glacier tour spend 2-3 hours on the glacier. Guests meet on-location, and trained guides provide them with proper glacier hiking gear. Once prepared, the group takes a short, 15-20-minute walk towards the glacier. While traversing towards the glacier, guests have the opportunity to observe Sólheimajökull from afar, along with features within the pro-glacial zone (Figure 5.1). Guests not participating in guided tours can also walk along this path, yet tour groups continue past a "do not go further" sign positioned at the glacier's face. Before stepping onto the glacier, guides instruct guests on hiking safety techniques and assist everyone in putting on crampons. Finally, the guided tour begins, and guests can experience the feeling of being on top of a glacier.

Figure 5.1: A group of tourists being led towards Sólheimajökull for a guided hike (Source: Photo by author).

Data were collected over three days from multiple tour groups hiking onto Sólheimajökull, but majority of the data were gathered from tourists who booked tours with the Icelandic Mountain Guide tour company. The researcher could not record guided tours during the time of data collection at Sólheimajökull. While attempts were made, the researcher was unable to attend a guided tour due to time restraints. In addition, recorders given to guides to carry during their tours were inaudible through thick clothing, and harsh weather conditions posed a risk to the recording devices. Despite this setback, the most semi-structured interviews took place with guides at Sólheimajökull, which offered insight into what would be presented during a tour and helped answer research questions.

5.2.1 Semi-Structured Interviews

A total of nine semi-structured interviews were conducted at Sólheimajökull. Seven of these interviews were with certified guides, one of whom just completed their training. Additionally, one interview was conducted with an individual who was on-site for their training and an individual that was a tour driver who often stopped at Sólheimajökull. Appendix E displays the demographic information of interviewees at each site.

Through transcription and coding, some major themes were revealed through the interview data. Unlike the other two study sites, guides at Sólheimajökull were each required to attend a training course called "Hard Ice," which is taught through multiple entities. Icelandic Mountain Guide has an internal course, but it is also taught through companies such as Asgard Beyond or the Association for the Icelandic Mountain Guide (AIMG). Along with physical training, the course also taught the interviewed guides a large portion of what they know about glaciers, and these teachings are carried into the guided tours. Training guides on climate warming and retreat is crucial towards improving tourist understanding of glaciers (Wang and Lan-Yue 2019), which makes glacier hiking guides particularly important, as they have been properly informed in both a formal and informal setting. While the researcher did not attend a guided tour of Sólheimajökull, it was emphasized through interviews and communication with guides that they are encouraged to mention glacier retreat and additional facts about the surrounding environment at some point during their tours. Discussion of glacial retreat is nearly impossible not to discuss at Sólheimajökull, as the guides often deal with both seasonal and daily challenges, such as access to the glacier, as a result of glacial retreat.

As previously stated, tour groups at Sólheimajökull have a small hike before reaching the glacier itself. As glaciers are ever-changing, glacier tourism companies operating at this site must accommodate and prepare for daily changes. According to multiple interviewed guides, they must walk the path at the beginning of each day to ensure it is still safe and accessible. As one guide stated, "The access to the glaciers are getting harder. It used to be big, so you could go on it at many places but now it's narrower. There's only one way to get to the glacier, routes have changed" (Guide A, personal communication, 2019); therefore, companies must stress the importance of wearing proper gear and practice caution with tourists.

Before a Sólheimajökull glacier hike begins, tour groups meet on location to put on crampons and acquire helmets and ice axes (Figure 5.2). Guides and other employees are present to assist tourists and assure equipment is on correctly. If a visitor arrives in insufficient clothing, they have the option to purchase appropriate gear as needed. Guests often await their tour in the Icelandic Mountain Guide meeting room. During operating hours, the company has a television that displays promotional information and an educational video. Of particular interest, the researcher observed a snippet of a video called "Meltdown," which explains the effect of climate change on Icelandic glaciers every few minutes (Icelandic Mountain Guides 2018). The introduction of the video presents words to the viewers that reads:

> *Climate change is one of the world's biggest challenges. The impact on Iceland's glaciers and surrounding ecosystem is undeniable. While there have been some irreversible changes, Icelandic Mountain Guide believes that the worst effects can be avoided. They are working to lessen the impact*

through education, environmental advocacy, and financially supporting projects that preserve the beauty of Iceland nature.

While waiting for a guided tour to begin, it is almost impossible not to see this video at least once. Mountain Guide is the only tour operation at Sólheimajökull that has a physical building that hosts its tourists; therefore, other companies lack this informational component. Despite this, there is signage posted near the parking area of Sólheimajökull that provides information on the history of the glacier, reviews basic glacier geomorphology, and displays pictures showing years of glacial retreat.

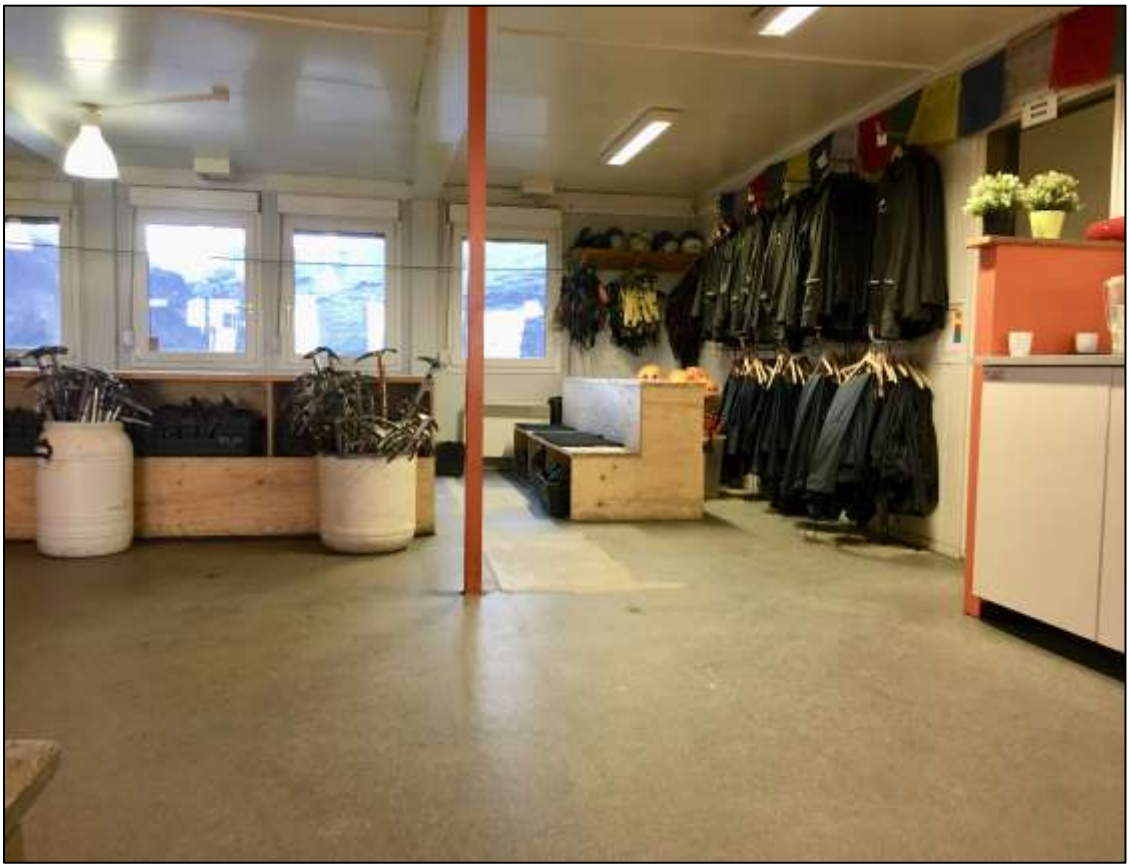


Figure 5.2: Icelandic Mountain Guide meeting room (Source: Photo by author).

Many similarities exist among glacier guides attitudes regarding tourist behavior and knowledge. When asked about tourists' understanding of glaciers, all interviewed guides agreed there is a mixed degree of comprehension. Specifically, interviewed guides acknowledged that, while there are visitors who are familiar with glacier science, even some scientists or glaciologists, there are many tourists who are extremely unversed in any glacier science. Consequently, all interviewed guides suggested it was essential to inform tourists on environmental topics, but six guides as stressed that they want the tourists to enjoy themselves, as they are typically in Iceland on vacation. Tourism operators are, thus, presented a difficult challenge of balancing education with entertainment when developing tour material. Yet, a study by North (2016) regarding show cave tourism found that the majority of tourists want to be educated and are seeking some degree of that during a nature tourism experience, despite hesitance and fear among guides believing they only wish to be entertained. Although this study is different from the study of glacier tourism, the themes can be carried across nature-based tourism attractions.

One guide stressed that climate change, in particular, should be emphasized more on guided glacier tours at Sólheimajökull. When asked what the most important takeaway message should be, they stated: "at least tourists are aware of the fact that glaciers are disappearing" (Guide B, personal communication, 2019). Overall, however, opinions of the impact of climate change on Sólheimajökull varied among guides. From interview transcriptions, most guides at Sólheimajökull believe climate change is occurring and hope that tourists recognize its impact, yet three guides also expressed discrepancies in if they believed climate change was the main contributing factor of

glacial retreat in Iceland. For example, Guide C (personal communication, 2019) stated that they "hope most people recognize this (climate change) is happening" while later saying, "…but the global warming thing… they can't prove that." In another discussion about glacial retreat with a different guide, they stated, "…it's hard to say if its climate change" despite giving examples beforehand of the lagoon growing and how that's most likely connected to climate change (Guide D, personal communication 2019). This uncertainty among guides towards the cause of the documented glacier retreat at Sólheimajökull can lead to hesitation when informing tourists about climate change. It is important that guides deliver a consistent and easily understood message. Cohen (1985) discusses that guides should act as a pathfinder or mentor. With this role in mind, guides must interpret in ways that produce active and mindful visitors who will question and reassess the way they view the world (Moscardo 1996; McDonnell 2001). Interpretation allows tourists to develop new insights and understand the environment they are in (McDonnell 2001). As Iceland is an ever-changing environment, glacier guides have a critical role to play in informing tourists in ways that are consistent with facts and common information. Nonetheless, post-assessments collected from tourists reveal that this did not influence perceptions of tourist knowledge on glaciers and climate change at Sólheimajökull.

5.2.2 Pre- and Post-Assessments

At Sólheimajökull, 79 tourists participated in both the pre- and post-outcomes assessment (Table 5.5); 16 individuals completed the pre-assessment only, and three only completed the post-assessment. As aforementioned, most assessments were

collected from tourists participating in a guided tour with Icelandic Mountain Guide, but additional results were gathered from guided tours with Troll Expeditions and Arctic Adventures tour companies. Permission to collect surveys from tourists was requested from Icelandic Mountain Guide before travel to Iceland took place and on-site for other companies after arrival at Sólheimajökull.

Table 5.5: Sólheimajökull pre-assessment question and responses (n=79) (Source: Created by author).

Why are you going on this glacier tour today?	**Sense of Adventure** 78%	**Sightseeing** 75%		**Expand Knowledge** 43%		**Entertainment** 33%	
Do you believe **climate change** can have a direct effect on the glacier you are seeing today?	**Yes** 91%	**Unsure** 8%		**No** 1%			
Where did these beliefs primarily come from?	**Online News Source** 67%	**Magazine/ Books** 32%	**Facebook** 11%	**Twitter** 4%	**Instagram** 13%	**School** 33%	**Work** 11%
Do you think **mass tourism** can affect the glacier you are seeing today?	**Yes** 63%	**Unsure** 28%		**No** 9%			
Do you think your knowledge on climate change will **broaden** after going on this tour?	**Yes** 52%	**Maybe** 35%		**No** 13%			

Pre-assessment results from Sólheimajökull suggest that the majority of participants went on the glacier hike for a sense of adventure or sightseeing; yet, guests were also given the option to offer additional comments regarding their attendance at the

glacier. Many of these responses related directly to climate change or the disappearance of glaciers. Table 5.6 below displays a breakdown of these responses. In total, eight guests left comments regarding climate change. Of these eight participants, 100% responded to both pre- and post-assessment responses believing that both climate change and mass tourism can impact Sólheimajökull glacier.

Table 5.6: Quotes from tourists at Sólheimajökull when asked for other reasons for visiting the glacier (Source: Created by author).

Theme	Quotes from Tourists
Glacier Retreat	- "Have the opportunity to walk on a glacier before they are gone." - "Experience glaciers because one day we may not be able too." - "See it before its gone." - "Try and see it before it disappears." - "To see a glacier before its gone."
Climate Change	- "Learn more about glaciers and climate impacts." - "Learn more about glaciers and climate change." - "Understanding climate change."

When asked about climate change, 91% (n=79) answered that they believe climate change is having a direct effect on Sólheimajökull. These beliefs primarily came from an online news source; yet, additional respondents stated they have also developed this belief from materials presented in magazines/books and school (Figure 5.3). In

addition, seven of the eight participants who left comments about climate change in the table above marked that they gained their knowledge primarily from school, suggesting that formal education efforts have informed some individuals on climate change. Findings from Welling and Abegg (2019) state that media coverage has become a common way for individuals to develop perceptions and beliefs on climate change. Considering a large number of tourists are absorbing their knowledge on climate change from media sources, which by design may or may not be reliable and scientifically accurate, it is crucial for glacier tour operators to convey accurate information during guided tours.

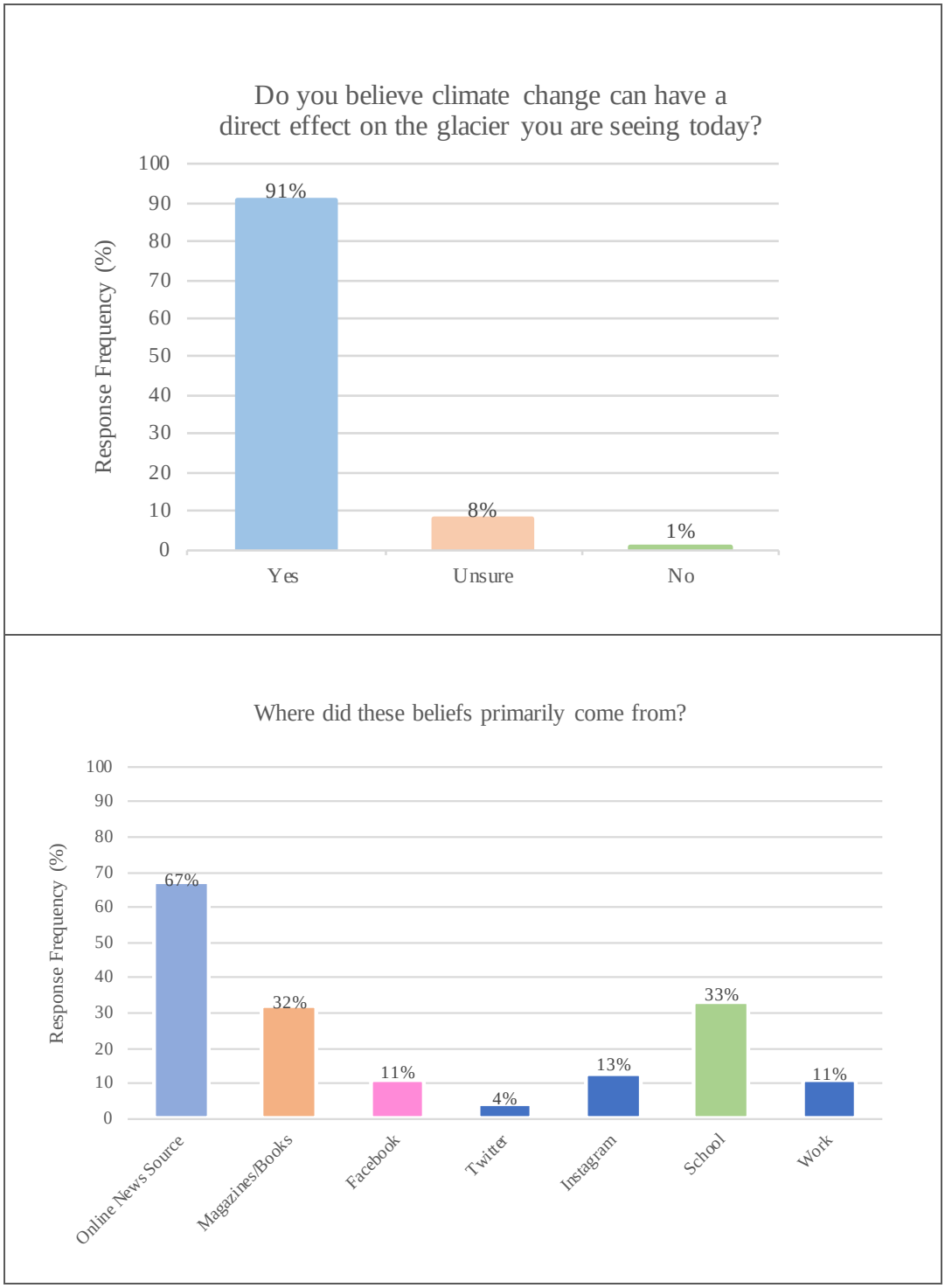


Figure 5.3: Response distribution of pre-assessment questions regarding beliefs on climate change at Sólheimajökull (n=79) (Source: Created by author).

Similar to questions regarding climate change, 63% of participants answered ‘yes’ when asked if mass tourism can impact Sólheimajökull; this suggests that some visitors are likely interested in learning about the health and longevity of the glacier. These tourists would likely be receptive to such educational material being shared during their guided tour experience. When asking tourists if their knowledge of climate change would broaden following the tour, results varied among participants (Figure 5.4). Of the tour participants, 52% responded ‘yes,’ but 35% answered ‘maybe,’ suggesting some tourists were unsure if an educational component would be incorporated into their tour; this could also indicate that visitors are expecting to learn something while on the tour. Considering many participants were embarking on the tour for a ‘sense of adventure,’ they may not have considered that there would be an educational component. As such, and supported by Graham et al. (2020), glacier hikes must be used as an outlet to inform guests on glacier science and climate change. Specifically, Graham et al. (2020) suggested that the continued promotion of education should be done through methods that influence visitors’ thoughts on how their behaviors impact the environment. Glacier tours become a unique venue to influence these thoughts and perceptions, as they are an experience that informally teaches visitors on topics such as climate change or glacier science.

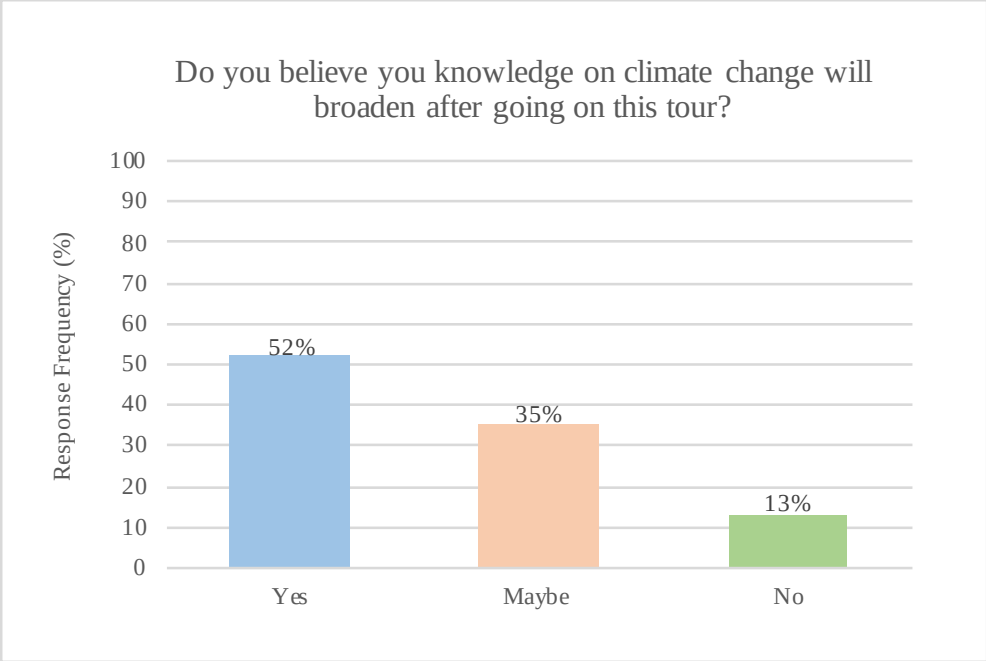


Figure 5.4: Response distribution of pre-assessment question: "Do you believe your knowledge on climate change will broaden after going on this tour?" (n=79) (Source: Created by Author).

An additional 16 participants completed only pre-assessments at Sólheimajökull. On occasion, visitors would return from their guided tour and forget about taking the post-assessment before departing. As stated, these results were analyzed in a separate Excel sheet from those who completed full assessments; yet, results were similar to those who completed both the pre- and post-assessment instrument. For example, 63% of pre-assessment only responses answered they were attending the guided tour for a sense of adventure. In addition, 94% of the participants believed that climate change could impact Sólheimajökull, with many of those beliefs coming from an online news source. Additionally, 75% believed mass tourism could affect the glacier, with 13% being unsure and another 13% disagreeing.

Comparatively, post-assessment results (that had pre-assessments completed with them) suggested that tourists gained more knowledge of glaciers after their guided tour (Figure 5.5). Furthermore, participants at Sólheimajökull were interested in learning even more beyond their tour experience, with one stating that “more scientific information would be welcome.” While most participants still agreed that their knowledge of climate change increased through participation in the tour, only 28% (n=79) confidently answered ‘strongly agree’ on the Likert-scale when asked if knowledge on climate change was increased through participation in the tour. In addition, fewer participants agreed that more scientific information should be incorporated, and a different glacier experience would have taught them more. This may suggest that Sólheimajökull glacier hikes are an appropriate outlet for improving understanding of glaciers and climate change.

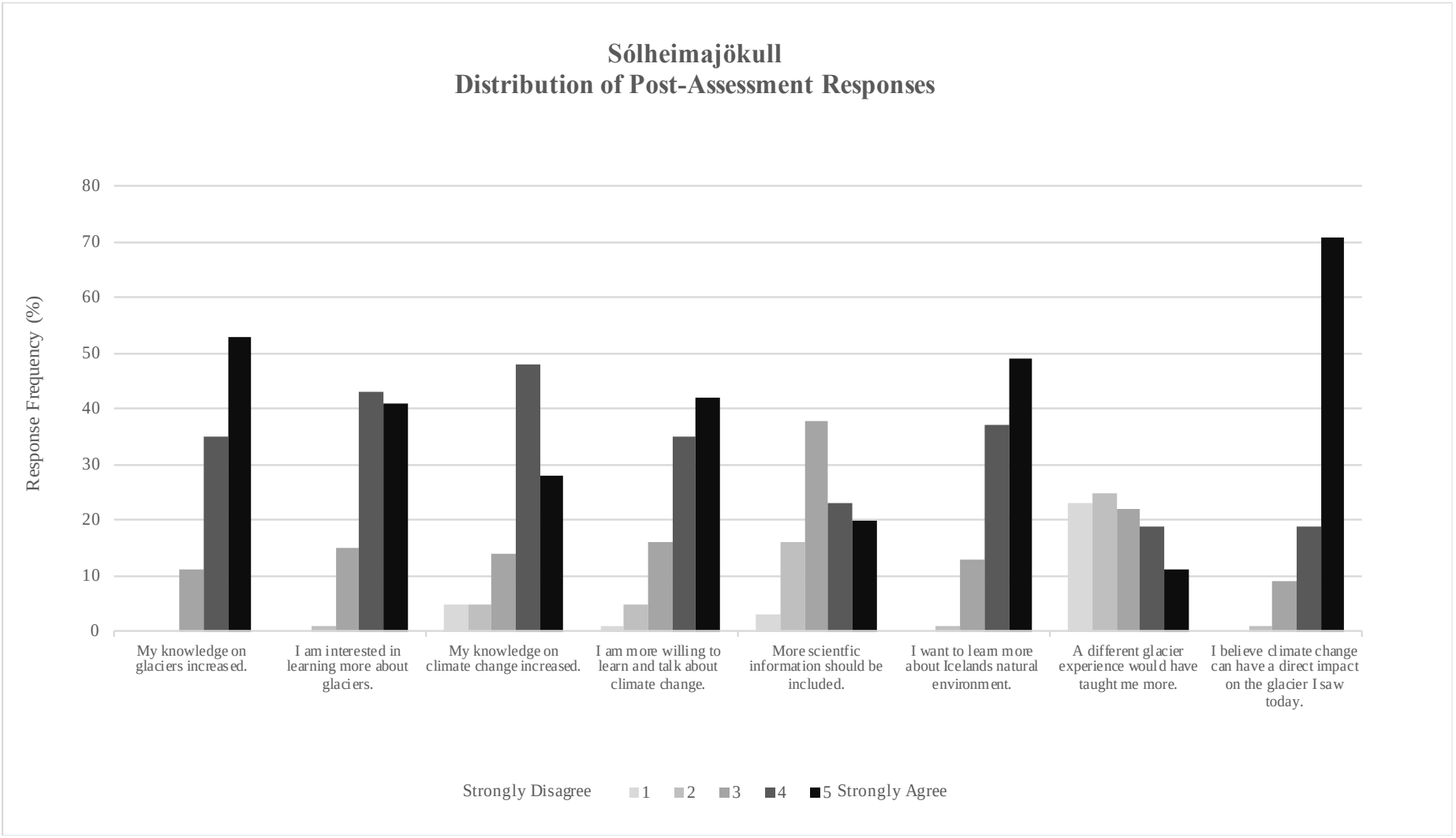


Figure 5.5: Distribution of post-assessment responses at Sólheimajökull (n=79) (Source: Created by author).

A high frequency of ‘strongly agree’ responses were reported when asked if participants believe climate change has a direct impact on Sólheimajökull, with 71% responding ‘strongly agree’ and 19% answering with ‘agree.’ Comparing these responses to the 52% of individuals that stated ‘yes’ when asked on pre-assessments if they think their knowledge on climate change will broaden, individuals participating in the Sólheimajökull glacier hike did gain knowledge on both glaciers and climate change during their guided tour. As tourists navigating around crevasses and meltwater ponds atop the glacier, glacier hikes provided visual evidence of retreat. Furthermore, before tourists step foot on the glacier, they traverse through the pro-glacial zone, which has also been considered to have high educational value (Moreau 2010; Bollati et al. 2013; Welling et al. 2015). Therefore, responses suggest that physical surroundings both before and during the guided tour may contribute to learning outcomes.

5.3 Into the Glacier

Into the Glacier is a more recently opened glacier tour operation in Iceland. Sitting on top of Langjökull, Iceland’s second largest glacier, is a human-made ice cave, crafted in 2010. This unique experience takes tourists inside the glacier for a one-of-a-kind experience, allowing them to see ‘blue ice’ and other features not visible on the surface (Into the Glacier 2018). Before traversing into the glacier, guests can also view a variety of features Langjökull offers, such as outlet glaciers and glacial lakes. The researcher spent one day onsite at the Klaki base camp, the meeting point for visitors. During this time, interviews and assessment data were collected before and after the three guided tours that took place that day. Similar to Sólheimajökull, tour recordings

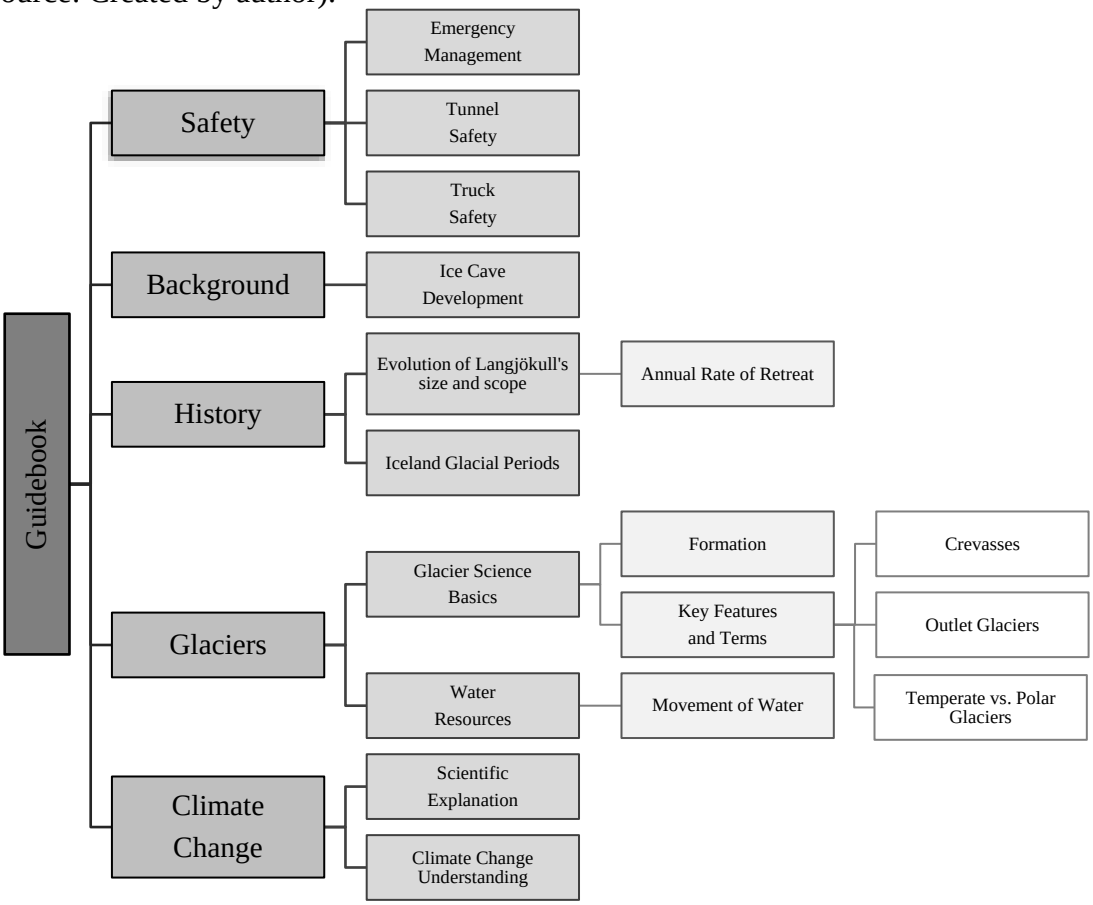
could not be collected at this site. Instead, the training guidebook used by all guides at Into the Glacier, was provided to the researcher and offered insight into what is presented during a tour.

5.3.1 Semi-Structured Interviews

At Into the Glacier, three interviews were recorded and transcribed. Interviews were conducted with each guide present during the single day of data collection. All three interviewees were working as guides at Into the Glacier, one of whom started when the attraction first opened in 2015. In contrast to guides interviewed at Sólheimajökull, no interviewed tour guide at Into the Glacier had a prior career-related to glacier tourism, nor were they required to have any certifications to guide tours at the site. Yet, Into the Glacier developed a *Guide Info* booklet, which serves as a foundation for guides understanding of all things related to the ice cave. Table 5.7 exhibits a flow chart of information presented within the guidebook (Guide J, personal communication, 2019). As stated in an interview, the guides have no written script to follow verbatim, but the handbook provides a framework for what should be mentioned during the tour. According to Guide J, “we do get a “script” with a bunch of things we’re supposed to learn. There’s also a lot of extra material that you aren’t forced to read, but it makes your life easier if you do” (personal communication, 2019). The researcher could not participate in any of the tours on the day of data collection. Still, the researcher had participated in a tour at Into the Glacier two years before data collection, allowing for some background knowledge and familiarity of the site and tour. Nonetheless, according

to communication with guides and tour managers, along with basic observations, guides reportedly follow the information in the handbook thoroughly.

Table 5.7: Flow chart of information represented in the Into the Glacier guidebook (Source: Created by author).



Comparable themes were found during interview coding for both Into the Glacier and Sólheimajökull. Guides at Into the Glacier face similar daily challenges such as access to glacier and seasonal changes. Into the Glacier changes the tour meeting point throughout the year in response to changing environmental conditions. Specifically, during summer months, if visitors have appropriate transportation, they can travel

directly to the Into the Glacier base camp. As winter approaches, the company sends a bus down to the community of Húsafell to pick up tourists and drive them to the base camp (Figure 5.6). The tour begins as tourists are driven up further onto Langjökull to approach the human-made ice cave. Altogether, the tours take 3-4 hours. According to guide interviews, weather circumstances can sometimes cause tours to be longer. Additionally, guides regularly have to shovel to the entrance of the actual cave due to constant snowfall.

Figure 5.6: Klaki Base Camp, Into the Glacier (Source: Photo by author).

All interviewed guides at Into the Glacier had similar opinions about tourist understanding and knowledge of glaciers as guides at Sólheimajökull. Each guide indicated that they often interact with guests who do not know what a glacier is; however, the guides acknowledged that many visitors come from regions where glaciers do not exist, so background knowledge would not be expected. Each guide stated that it is important to inform tourists about glaciers and environmental topics, with one guide even emphasizing that informing guests "…is unavoidable, you're inside an ice tunnel on a glacier that is melting away and we wouldn't do a tour like this without mentioning the nature we're traveling through" (Guide K, personal communication, 2019).

Comparably, when asked what the biggest take-away message should be, all guides emphasized they hope tourists understand the global warming impact and learn something. Furthermore, they desire that tourists learn to respect nature, as emphasized by Guide J (personal communication, 2019), who stated unequivocally that following a guided tour they hope visitors recognize "that nature is sublime, and that it is fragile,=." Post-assessment results suggest that tourists gained more knowledge following the guided tour, as a combined 91% agreed or strongly agreed that climate change is having a direct impact on the glacier they saw. Considering educational outcomes did increase, tourists likely leave the guided tour with a better appreciation for the natural environment. An appreciation and understanding of nature and climate change may already exist before the tour occurs, as 86% of participants on the pre-assessment did believe climate change could impact the glacier they were about to see. Since the ice-cave is a human-made attraction, guides at Into the Glacier are very aware of the vulnerability of glaciers, specifically Langjökull, and are passionate about keeping it

accessible for as long as possible. Post-assessment results and interview findings suggest that this passion and interest is carried into the guided tour, as 43% of tourist agreed that their knowledge on climate change increased and 52% strongly agreed their knowledge on glaciers increased following their guided tour.

Overall, most tourists seemed to learn a lot while on a tour and strongly agreed that climate change is impacting Langjökull and the ice cave. These same tourists may have been confused about if the human-made ice cave could be affected by climate change prior to the tour. A review of these data suggests that Into the Glacier is successfully producing the take-away message that the interviewed guides hope for, as well as a tour that can be an effective venue for informal environmental education.

5.3.2 Pre- and Post-Assessments

At Into the Glacier, 90 tourists participated in both the pre- and post-assessments, with five individuals completing only the pre-assessment. Every individual on-site the day of data collection was asked to participate in an assessment (Table 5.7). Unlike at Sólheimajökull and Jökulsárlón, the research team could not collect assessments before and after the tour; rather, tourists filled out both sides of the assessment following their guided tour. Tour transitions were fast-paced; upon arrival to the base camp and collecting tickets, tourists almost immediately transferred into another vehicle to traverse the remaining distance to the entrance of the human-made ice cave. As such, no time was allotted for tourists to complete an assessment prior to the tour beginning. Although participants completed both the pre- and post-assessment at the same time, it

was emphasized that the first portion of the assessment was meant to be taken prior to the tour, and they were asked to respond with that in mind.

In contrast to Sólheimajökull, more variety about why tourists were participating in a tour was documented at Into the Glacier, with responses dispersed between 'sense of adventure,' 'sightseeing,' and 'to expand knowledge.' This distribution may be due to the distinctiveness of the guided tour, as it advertises itself as a "once in a lifetime opportunity" (Into the Glacier 2018), implying that it will be unique and potentially informative. In addition, except for 4% (n=90) of respondents saying 'maybe,' 96% of participants reported that they believe climate change can affect Langjökull glacier (Table 5.8), with most of these beliefs stemming from an online news source. Similar to tourists at Sólheimajökull, media, thus, played a significant role in individuals' understanding of climate change. Other participants indicated science, other tours, and personal conversations were sources of their knowledge and beliefs; one respondent even reported "this form," suggesting that the questionnaire itself may have provided insight into climate change that had not before been considered.

Table 5.8 Into the Glacier Pre-assessment question and responses (n=90) (Source: Created by author).

Why are you going on this glacier tour today?	**Sense of Adventure** 62%	**Sightseeing** 74%		**Expand Knowledge** 53%		**Entertainment** 32%	
Do you believe **climate change** can have a direct effect on the glacier you are seeing today?	**Yes** 96%	**Unsure** 4%		**No** 0%			
Where did these beliefs primarily come from?	**Online News Source** 70%	**Magazine/ Books** 41%	**Facebook** 14%	**Twitter** 8%	**Instagram** 11%	**School** 27%	**Work** 14%
Do you think **mass tourism** can affect the glacier you are seeing today?	**Yes** 64%	**Unsure** 24%		**No** 11%			
Do you think your knowledge on climate change will **broaden** after going on this tour?	**Yes** 70%	**Maybe** 21%		**No** 9%			

In contrast to responses towards climate changes impact on the glacier, confidence decreased when asked if mass tourism can impact the glacier participants were touring (Figure 5.7), with 64% responding ‘yes’, 24% of participants stating ‘unsure’, and 11% indicating ‘no’. Additionally, 70% of individuals responded ‘yes’ when asked if they thought they would learn more about climate change, with similar distribution as the mass tourism question between the ‘maybe’ and ‘no’ responses. Nearly all responses on the pre-assessment may be a result of the Into the Glacier

excursion being a human-made attraction, causing potential confusion as to if the ice-cave itself is vulnerable enough to be influenced by climate change.

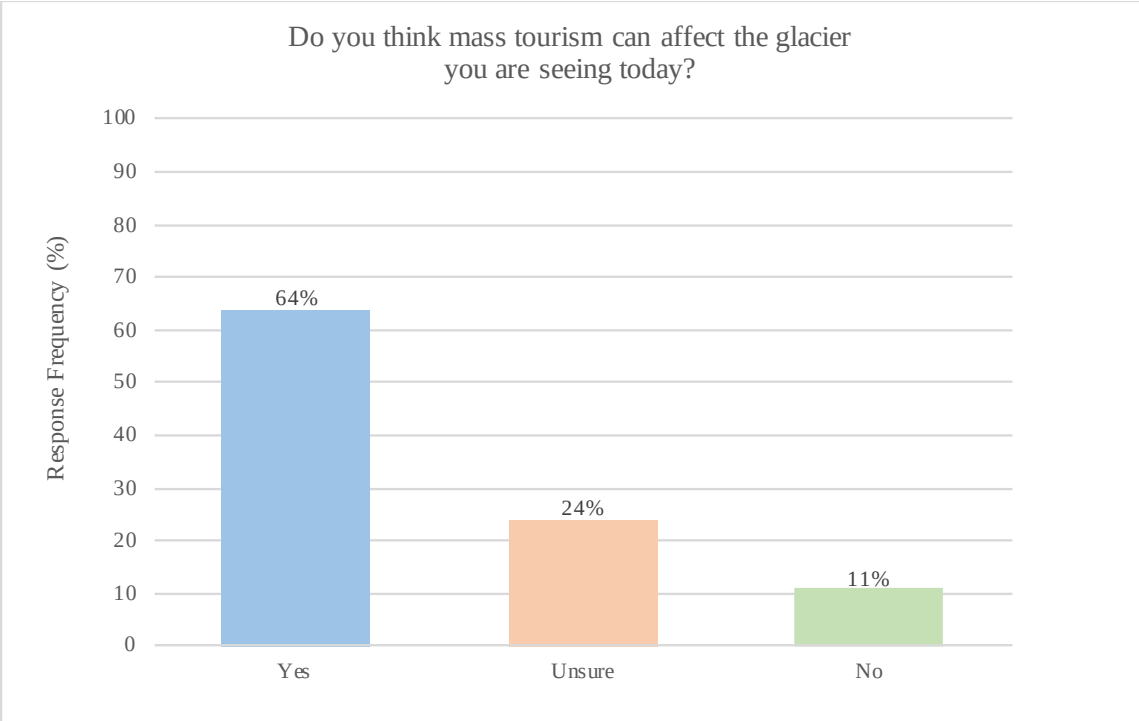


Figure 5.7: Into the Glacier pre-assessment question: "Do you think mass tourism can affect the glacier you are seeing today?" (n=90) (Source: Created by author).

In addition to the pre-assessment results described above, five additional participants at Into the Glacier completed just the pre-assessment. Like previously discussed results, the majority were attending the guided tour for a sense of adventure. Additionally, 100% of these participants agreed climate change could impact the glacier they are seeing. Sixty percent of these individuals obtained these beliefs from magazines/books, while others learned from online news sources or Facebook. When asked about mass tourism impact, 60% responded they agree it could impact the glacier,

with the other 40% dispersed across ‘unsure’ or ‘no’ responses. Lastly, 60% did believe their knowledge of climate change would increase with 40% responding with ‘maybe.’

Post-assessment results suggest that the Into the Glacier tour is doing a respectable job at informing tourists on environmental topics. Over 50% of participants strongly agreed that their knowledge of glaciers increased after embarking on the tour, with 39% strongly agreeing and 48% agreeing that they are interested in learning more about glaciers after attending the tour (Figure 5.8). It has been discussed that glacier sites provide “undoubtedly tangible evidence that our planets climate is changing, and the accelerated pace of worldwide glacier retreat makes visitors more aware of the consequences of this change” (Welling et al. 2015, 645). These results may suggest that physically seeing the inside of a glacier allows visitors to absorb information they may not have been gained elsewhere. In addition, the tour company has posted signage along the entirety of the tour, with stops often occurring for visitors to read and take photos.

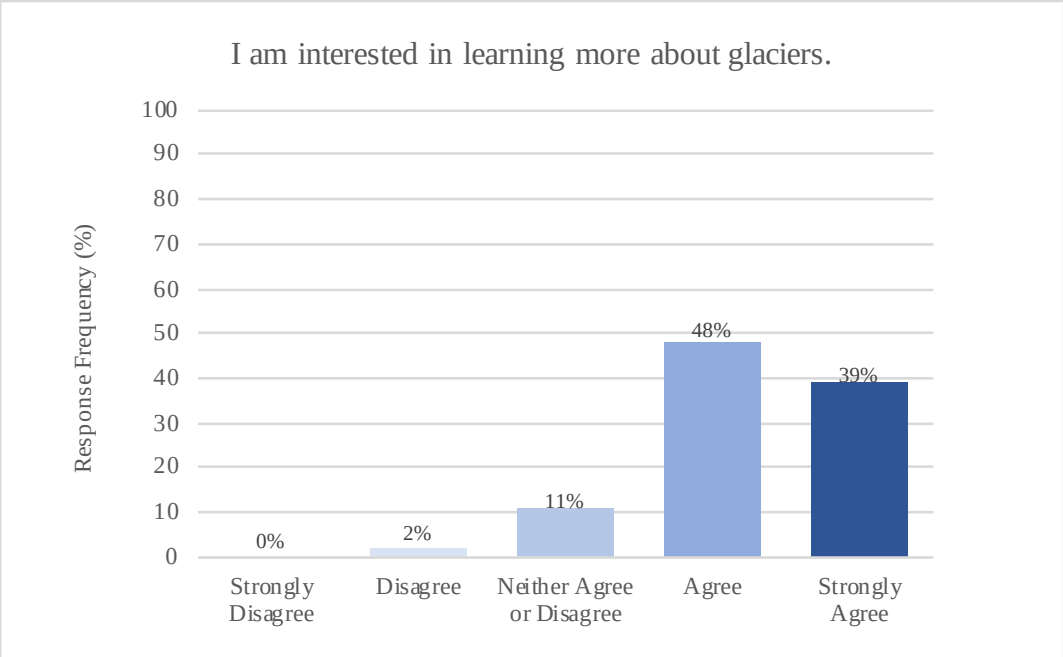


Figure 5.8: Response distribution on post-assessment question regarding tourist understanding and willingness to learn at Into the Glacier (n=90). Responses obtained from the statement, "I am interested in learning more about glaciers following this tour." (Source: Created by author).

In contrast to the findings shown above, response agreement decreased when tourists were asked if more scientific information should be included in the tour, with 36% of participants neither agreeing nor disagreeing (Figure 5.9). Furthermore, when asked if they were willing to learn more about Iceland's natural environment, 36% agreed, and 20% neither agreed nor disagreed. This finding may be a result of the already abundant amount of content along the path, combined with the information guides present as well. Compared to the study done by Graham et al. (2020), this author found that tourists developed an increased knowledge of the geology of Iceland after reading interpretive signs; therefore, if guests at Into the Glacier read signs along the trail, as well as listen to the guide's interpretation, they may leave the tour learning more than they expected, resulting in a successful attempt to inform visitors on glaciers and

climate change science. It is not possible to determine if this tour results in an oversaturation of information from this study; future research could explore this notion more to determine at what point the information becomes too much.

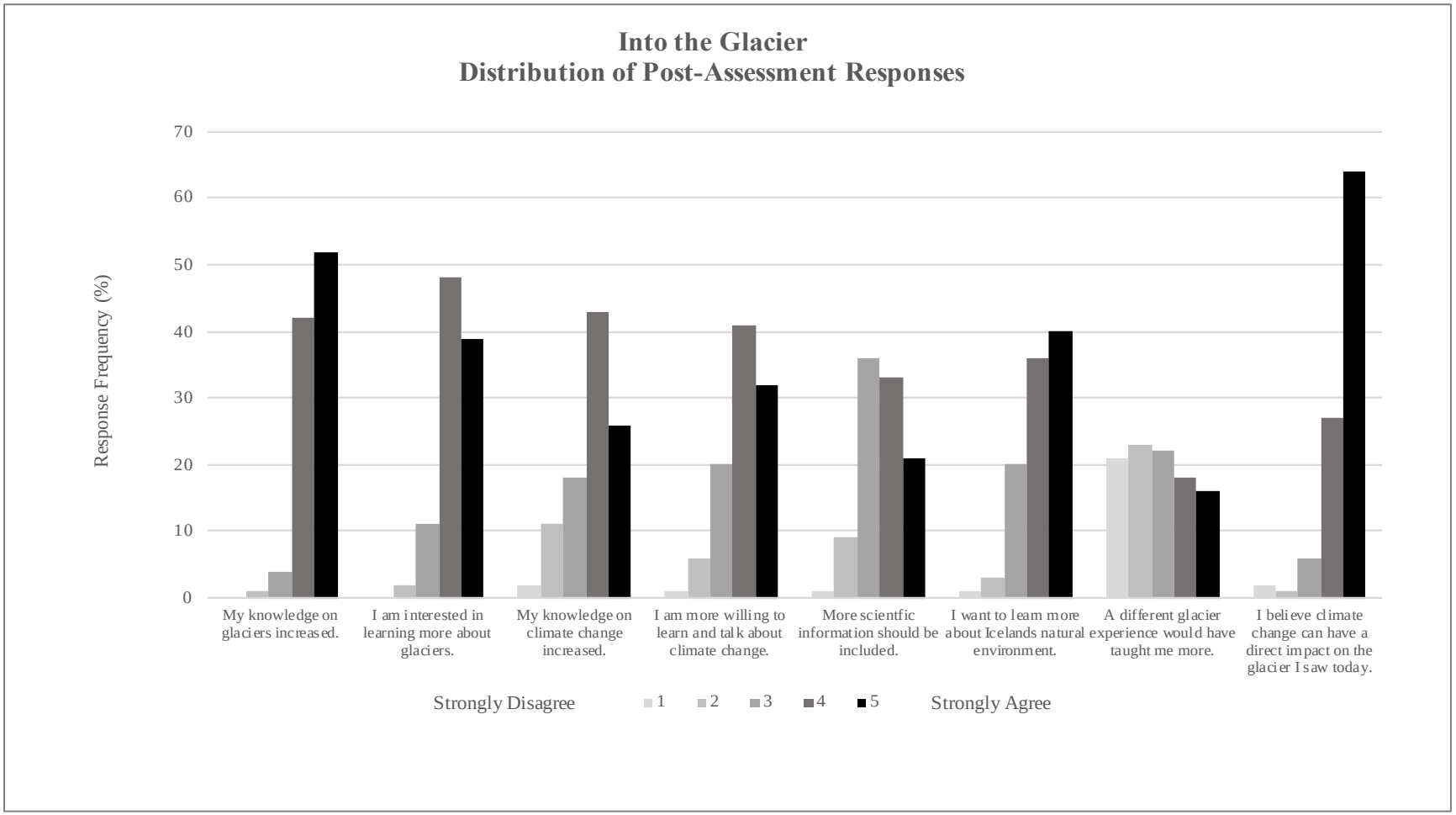


Figure 5.9: Distribution of Post-Assessment responses at Into the Glacier (n=90) (Source: Created by author).

Regarding questions about climate change, 43% of assessment participants 'agreed' their knowledge increased, with 26% noting they 'strongly agreed.' When asked if they are more willing to talk about climate change following the tour, 41% stated 'agree,' 32% said 'strongly agree', and 6% disagreed. These responses suggest that Into the Glacier has effectively communicated climate change science with tourists in ways that they can understand and feel comfortable sharing with others after the tour. This finding supports Wang and Lan-Yue (2010, 175) who suggest that educational development on glacier sites can "not only let tourists understand glacier change, ecological environment, and human activities, but also enhance tourists' awareness to protect glacier resources." Furthermore, 16% of respondents answered 'strongly agree' when asked if a different glacier tour would have taught them more about climate change, while 21% strongly disagreed. As this is a one-of-a-kind experience, it provides informal learning opportunities not viable through any other guided glacier tour. Furthermore, 64% of participants stated they 'strongly agree' climate change can impact the glacier they saw, with only 2% of individuals responding, 'strongly disagree,' and one 1% answering 'disagree' on the assessment; one respondent wrote on their survey that the tour was "informative, but sad to learn earth is learning that quick." This reiterates the fact that Into the Glacier tours do teach about climate change, and this response may encourage that visitor to live a more climate-responsible lifestyle. Comparing post-assessment to pre-assessment data indicates that tourists are gaining knowledge of climate change during their guided tour, specifically information related to the impact climate change has on Langjökull and the human-made ice cave.

5.4 Jökulsárlón

Jökulsárlón boat tours take place in Southern Iceland. Jökulsárlón is a naturally formed glacier lagoon consisting of meltwater from the Breiðamerkurjökull outlet glacier. Jökulsárlón is famous for its vivid blue color and has become a top attraction for tourists in Iceland. As a result of this popularity, the tourism company Glacier Lagoon, began leading boat tours on the lagoon, so tourists have the chance to see the icebergs up close and personal. The researcher spent three days at Jökulsárlón collecting data.

Interviews and assessments were collected from those taking part in the Amphibian boat tour, a 30-40-minute guided boat ride along the lagoon with roughly 20 people. The researcher focused specifically on the Amphibian boat tour over the Zodiac boat tour due to the frequency of daily tours and the number of guests who participate in each. Future research may assess both of the tours and make comparisons among them. Amphibian boat tours were fully booked almost every day of research, with the weather being the main contributor to cancellations or less tourism activity. Guests can purchase tickets online or on-site. Once they have acquired their ticket, guests must line up next to a boat ramp (Figure 5.10); both pre- and post-assessments were distributed at the ramp.

Figure 5.10: Guests on board for the Jökulsárlón Amphibian Tour (Source: Photo by author).

5.4.1 Semi-Structured Interviews

Only two interviews at Jökulsárlón could be conducted at the time of data collection. Tour transitions were very fast-paced, and time was focused mostly on collecting assessment data. Additionally, the same five guides were present each day the research team was on-site, with three refusing to participate in an interview. While interviews were not easily obtainable, unlike at Sólheimajökull and Into the Glacier, recordings of guided tours were collected at this study site. Three boat tours were recorded and transcribed, with the research team present for one of them.

Qualifications to obtain a guiding job at Jökulsárlón were the least strict among the study sites. Each interviewed guide stated that the main requirement to guide tours at Jökulsárlón was to speak more than one language. Additionally, one of the guides mentioned they must attend a crisis-management class once hired. Other employees of Glacier Lagoon are in charge of driving the boat and navigating among the lagoon. Since the lagoon is constantly changing, the driver is responsible for choosing the safest path for the tours each day.

In contrast to Into the Glacier excursions and Sólheimajökull glacier hikes, guides at Jökulsárlón are strictly there to present the information. Since the boat tours are an additional attraction to the lagoon itself, guides are not required to perform site maintenance or upkeep; therefore, their primary duties are to assure guests on the boat are wearing life vests properly and to both inform and entertain guests. From researcher observations, tours followed an informative script, and guides often discuss a series of common themes, with some variations among guides. For example, each of the recorded guides discussed color absorption and reflection and how it relates to the colors of the icebergs in the lagoon. Although Sólheimajökull and Into the Glacier differ from this because they do not have a standard script, learning outcomes among the three sites were consistent.

Similar to interviews at Sólheimajökull and Into the Glacier, guides at Jökulsárlón agree that tourists have a mixed understanding of glaciers. While it was mentioned that there are guests who are more familiar with glaciers, interviewed guides reported that there are many tourists who are not at all familiar. From observations, the lagoon is a regular stop for larger tour groups, each following a strict schedule;

therefore, many guests rush to get photos, take the boat tour, and then load back onto their tour buses.

Despite the tours presenting a suitable amount of scientific information, interviews suggest that guides sense that the information is not being absorbed completely. One guide even stated, “In my two years of guiding, I’ve had two people after my tour come up to me and ask, “what can we do to minimize our carbon footprint,” two people. I deal with thousands of people a year” (Guide M, personal communication, 2019). Jökulsárlón is a unique case study in this sense, as it is a significant venue to improve understanding of climate change science; yet, as guided boat tours must operate quickly to accommodate the thousands of visitors annually hoping to traverse the lagoon, it becomes a challenge to inform tourists while also giving them a satisfying experience. This finding relates to tourism carrying capacity, which is defined as “the maximum number of visitors that can be in an area without an unacceptable alteration in the physical environment and without unacceptable decline in the quality of experienced gained by visitors” (Sæþórsdóttir 2010, p. 30-31). As Getz (1983) identified, an important category of carrying capacity is the social and political component. Crowding can often negatively influence visitor dissatisfaction within an area; yet, Getz (1983) discussed that dissatisfaction can occasionally be mitigated through the development of more attractions. Additionally, dissatisfaction is also lessened if it is the visitors first time on the site, as they are more tolerable. At Jökulsárlón, the boat tour allows guests to remain onsite, but observe features from the middle of the lagoon, rather than just the outskirts, like many guests have to experience.

The findings by Getz (1983) regarding carrying capacity and tourist satisfaction still, therefore, hold true at locations such as Jökulsárlón.

5.4.2 Pre- and Post-Assessments

Boat tour transitions at Jökulsárlón are fast-paced, occurring every 20-30 minutes when on schedule. As soon as one boat departs, individuals participating in the next tour immediately begin lining up to board the next boat. Therefore, there were occasions when visitors would leave before completing the post-assessment. Nonetheless, the highest number of assessments were collected at Jökulsárlón, with 94 visitors completing both the pre- and post-outcomes assessments (Table 5.9), 35 completing the pre-assessment only, and one visitor volunteering to take the post-assessment following their tour without taking the pre-assessment prior to tour departure. Except for a short description of pre-assessment-only results, the data described below represent assessments in which both pre- and post-outcomes assessments were completed.

Table 5.9: Jökulsárlón pre-assessment question and responses (n=94) (Source: Created by author).

Why are you going on this glacier tour today?	**Sense of Adventure** 52%		**Sightseeing** 65%	**Expand Knowledge** 35%		**Entertainment** 17%	
Do you believe **climate change** can have a direct effect on the glacier you are seeing today?	**Yes** 96%		**Unsure** 4%	**No** 0%			
Where did these beliefs primarily come from?	**Online News Source** 68%	**Magazine/ Books** 31%	**Facebook** 12%	**Twitter** 0%	**Instagram** 4%	**School** 34%	**Work** 14%
Do you think **mass tourism** can affect the glacier you are seeing today?	**Yes** 64%		**Unsure** 30%	**No** 6%			
Do you think your knowledge on climate change will **broaden** after going on this tour?	**Yes** 42%		**Maybe** 51%	**No** 7%			

In addition to visitors that completed both sides of the assessment, 35 individuals completed only pre-assessments. Most of these guests participated in a boat tour for a sense of adventure and sightseeing. When asked if climate change can directly affect the glacier they are seeing, 94% (n=35) stated ‘yes’ with the remaining participants being unsure. As such, 80% of visitors gained these beliefs from an online news source, with one individual saying that they have noticed a physical temperature change. Similarly, 51% of these individuals believe mass tourism could impact the glacier they saw, with 40% being unsure. Lastly, 48% of the respondents believe their knowledge of climate change would broaden following the tour, with 11% believing it would not.

Similar trends were found in the Jökulsárlón pre-assessments as to those at Sólheimajökull and Into the Glacier when asking visitors why they took a boat tour, as respondents at Sólheimajökull and Into the Glacier were mainly visiting for either a 'sense of adventure' or 'sightseeing.' At Jökulsárlón, 65% (n=94) answered for sightseeing; yet, 52% also visited for a sense of adventure and 35% to expand knowledge (Figure 5.11). Often, guests would circle more than one response on the assessment instrument. This is similar to the Annual Tourism report conducted in Iceland, which found that the top reason travelers decided to visit Iceland was for "the country's nature or particular natural feature," (Óladóttir 2018, 18) which could involve both sightseeing and gaining a sense of adventure. In addition, some guests wrote comments such as: "chance to see something before it no longer exists," "see something that may not be there one day," "to see before it's gone," and "would like more scientific perspective." These responses suggest that some visitors are already aware of climate change impact, and they are exhibiting the practice of last-chance tourism (Lemelin et al. 2010) to destinations in Iceland. Additionally, these responses are similar to findings by Graham et al. (2020), who found many visitors in Iceland were traveling to these nature-based attractions before they melt away entirely.

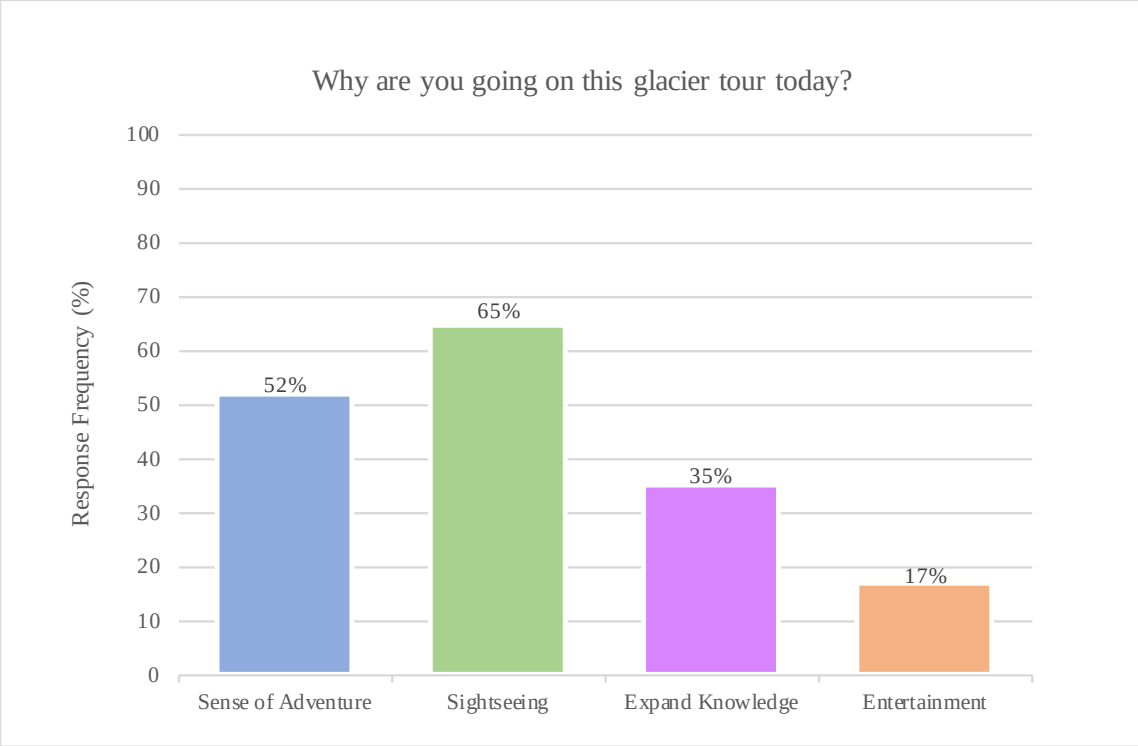


Figure 5.11: Jökulsárlón pre-assessment question: "Why are you going on this tour today?" (n=94) (Source: Created by author).

When asking tourists if climate change can affect the glacier they would see today, 96% (n=94) of respondents answered 'yes.' Considering the lagoon is physical evidence of glacial retreat, this could have influenced visitor responses regarding climate change. This type of informal learning opportunity may "result in a more knowledgeable individual possessing an incrementally enhanced motivation and capacity to learn more in the future" (Falk 2005, 266). Similar to the other study sites, beliefs about climate change primarily came from an online news source. Despite this response, 51% of visitors were unsure if their knowledge of climate change would broaden following the boat tour, with an additional 7% believing it would not (Figure 5.12). For this question, there were occasions where participants would circle more than one response, such as

'yes' and 'unsure;' in these instances, both of those responses were accounted for in the final dataset. This finding may be a result of many visitors assuming that the tour is strictly for sightseeing within the lagoon. In addition, many guests arrive with large tour groups. For example, Extreme Iceland (2020) offers tour packages that range from two to seven days, many of which include a stop at Jökulsárlón and an option to participate in a boat tour. If a tourist chooses this option, they often have pre-booked tickets included in the itinerary; therefore, they may have done little research of the lagoon before arriving at the site.

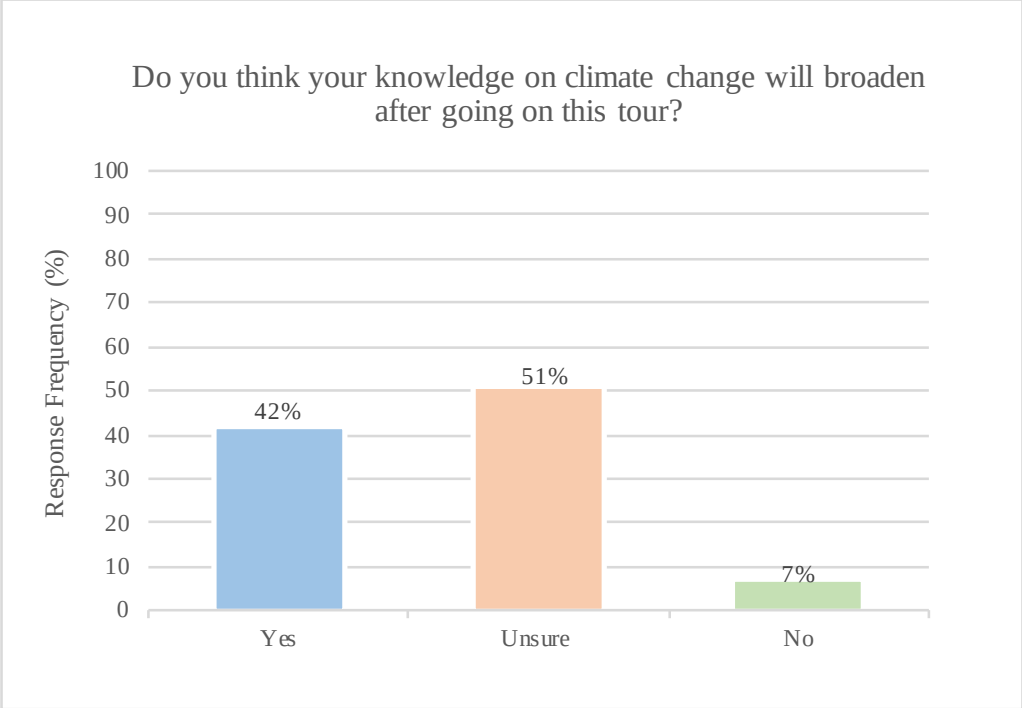


Figure 5.12: Jökulsárlón pre-Assessment question: "Do you think your knowledge on climate change will broaden after going on this tour?" (n=94) (Source: Created by author).

At Jökulsárlón, assessment participants believed that mass tourism can affect the glacier (Figure 5.13). Considering Jökulsárlón is one of the most popular stops in Iceland, responses about mass tourism may be a result of individuals physically observing the extensive amount of people in the same proximity. Jökulsárlón is one of the most popular attractions in Iceland; the site has experienced significant development in recent years with a large parking lot, café, and gift shop all on-site. The surrounding environment may have also influenced responses to this question, as visitors can physically see the glacier slowing melting into the lagoon, even from the parking lot of the site. Once again, this corresponds with discussing from Welling et al. (2015) that describes the pro-glacial zones to have extensive educational value.

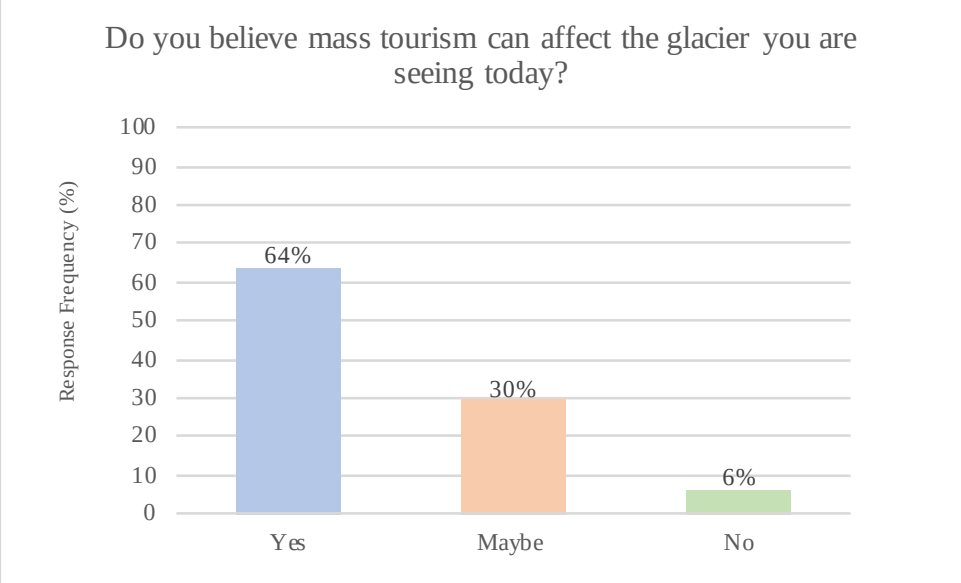


Figure 5.13: Jökulsárlón pre-assessment question: "Do you believe mass tourism can affect the glacier you are seeing today?" (n=94) (Source: Created by author).

Following the tour, post-assessments suggest visitor knowledge increased after completing the guided tour (Figure 5.14); 43% agreed that their knowledge increased

following the tour, and 45% agreed they are interested in learning more. Only 29% of participants agreed that their understanding of climate change increased specifically as a result of the tour. Two participants stated on their assessment that the tour should include more information on climate change, so they can become more aware of its impacts. In addition, 29% agreed they were more willing to talk about climate change following the guided tour, while 15% disagreed. Consequently, 37% of respondents strongly agreed that more scientific information should have been included, and 46% strongly agreed they would have liked to learn more about Iceland's natural environment. Despite these responses, there was some disagreement when asked if a different glacier tour would have taught them more about climate change, as 29% of participants agreed with this statement, and 16% strongly disagreed. Additionally, 28% responded with a three on this Likert-scale question, signifying they were unsure if they agreed with the statement or not.

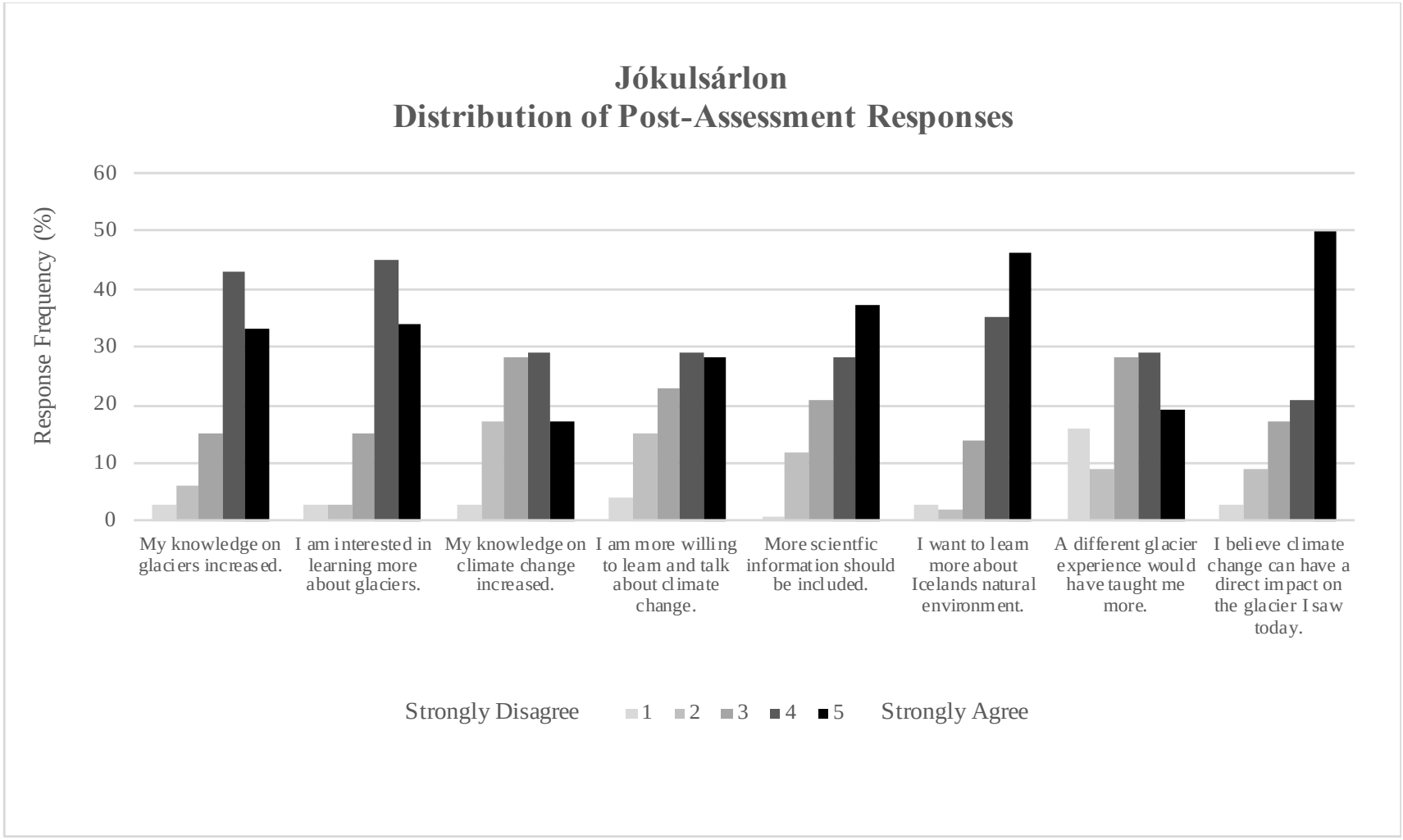


Figure 5.14: Distribution of post-assessment results at Jökulsárlón (n=94) (Source: Created by author).

Post-assessment responses may be a result of the tour's timing, as guides only speak 15-20 minutes overall, and it is given speedily, possibly making it difficult for visitors to process the information that was provided. Despite the hesitance of the previous question, 50% of individuals responded 'strongly agree' when asked if climate change is directly impacting the glacier they saw. This response decreased from pre-assessment responses regarding climate change, implying that the guided boat tours at Jökulsárlón may decrease tourist understanding of climate change. This finding further emphasizes the importance of aligning tour content with site experience and landscape and stresses the importance of the guides' role during a tour. Weiler and Davis (1993) expanded on the roles of guides, as outlined in Cohen (1985), to include the natural environment (also discussed as resource management). This focus has two main roles: the motivator and the environmental interpreter. Through these roles, guides must present in ways that promote responsible tourist behavior and communicate an understanding of environmental issues. In short, it is critical to develop a message that is aligned closely with the tour experience, surrounding environment, and site. Some inconsistencies regarding the information presented by guides are present during Jökulsárlón boat tours, which is discussed further in section 5.4.3.

5.4.3 Guided Tours

Jökulsárlón glacier lagoon has adapted dramatically to tourism in recent years. It is a quick and noticeable stop alongside the main highway (more familiarly known as "ring road"), so it is an opportunistic spot to educate tourists on glaciers and climate change. The Jökulsárlón boat tours are an entertaining way to meet this goal. Before the

guide begins speaking during a tour, a piece of ice in the lagoon is acquired by another employee and brought onto the boat. To add amusement to the tour, the guide will carve the ice into a heart to be passed around the boat. From observations, many guests are very entertained and enjoy this part of the tour. Afterward, the guide begins to deliver a speech about the glacial lagoon. From the three acquired tour recordings, guides followed a very similar script; yet, there were some slight discrepancies between each guide. Table 5.10 displays major themes from boat tour transcriptions and key points described by each guide.

Table 5.10: Jökulsárlón boat tour major themes and points (Source: Created by author).

Major Themes	**Guide N**	**Guide O**	**Guide P**
Background	-Age of lagoon -Temperature of lagoon vs. temperature of the ocean -Vatnajökull size and major features -Analogy of a "hand with nineteen fingers" that describes Vatnajökull outlet glaciers	-Vatnajökull size and major features -Analogy of a "hand with nineteen fingers" that describes Vatnajökull outlet glaciers	-Vatnajökull size and major features; thickness of ice and sizing perspective -Analogy of a "hand with nineteen fingers" that describes Vatnajökull outlet glaciers -Glacier movement
Glacial Retreat	-Past surface area vs. current, emphasizing the glacier is **retreating fast** -Retreat rate per year -Retreat is happening "**not only from** global warming, but also due to saltwater in the lagoon"	-Retreat is happening **due to saltwater** flowing into the lagoon -Saltwater touches the ice and causes it to melt faster -Glacier will most likely be gone in 40 years	- Past surface area vs. current -Retreat rate per year "…main reason for that is **not** global warming. I'm not saying global warming is not affecting it at all, but it's **not the main reason** here" -Global warming will affect ice thickness, but Breiðamerkurjökull is unique because of its interaction with saltwater
Size and Scope	-Surface area of lagoon -Constant growth due to melting -Emphasizes that the lagoon will always look different -Depth of water (deepest lake in Iceland)	-Depth of water (deepest lake in Iceland)	-Surface area of lagoon -Depth of water (deepest lake in Iceland)
Biodiversity	-Seal species: Harbor and Grey; discusses why they are in the lagoon -Fish species: Trout, Herring, Cod	-Seal species: There is a lot of them; discusses why they are in the lagoon -Fish species: salmon and trout -Bird Species: Seagulls and Arctic tern; tells stories of the birds	NA.
Iceberg	-Color of icebergs; color absorption and reflection -Volcanic ash cover -Iceberg size on the surface vs. underwater	-Color of icebergs; color absorption and reflection -Volcanic ash cover -Iceberg size on the surface vs. underwater	-Color of icebergs; color absorption and reflection -Volcanic ash cover

As shown in Table 5.10, there are many similar themes between guided tours at Jökulsárlón. While no interviewed guides specifically mentioned a provided script, tour recordings suggest that they are given a structured document to follow when presenting the information. Tour transcriptions were broken into five major themes: background, glacial retreat, size and scope, biodiversity, and icebergs. While transcriptions were very similar, each guide discussed at least one of the themes in more detail than others. Each guide started their speech with a discussion of background information and facts about the lagoon. To inform a wide variety of demographics, they often kept information simple and easy to understand. For example, when discussing the glacier, each guide used the analogy of a "hand with nineteen fingers." They described Vatnajökull to be the palm, while each of its nineteen outlet glaciers is an individual finger, Breiðamerkurjökull being one of them. While this may seem like basic information, analogies have often been considered within the literature as an important outlet for scientific progress and understanding (Glynn 1991). Other common points mentioned were the size of the lagoon, its biodiversity, and why pieces of ice were specific colors.

The most significant difference in tour transcriptions was how guides explained glacial retreat. Upon analysis of recordings, each guide explains glacial retreat in different ways. Guide N emphasized that retreat of Breiðamerkurjökull is a result of both global warming and from saltwater in the lagoon, stating "…this is happening not only because of global warming, but also because the water in the ocean that flows over into the lagoon from the bridge, it brings in warm and salty water," (personal communication, 2019). In contrast, Guide O stated that retreat is caused by saltwater flowing into the lagoon and does not mention global warming at all, indicating that "it's

disappearing fast because the ocean is pushing saltwater in the lagoon," (personal communication, 2019). Lastly, Guide P (personal communication, 2019) specified global warming is not the main contributor to the retreat of Breiðamerkurjökull, emphasizing "the main reason for that (retreat) is not global warming. I'm not saying global warming is not affecting it at all I'm just saying it's not the main reason here. Global warming will affect the ice thickness, like most of Iceland." Despite discrepancies, each guide indicated that the glacier is unique due to its interaction with saltwater, but global warming can still affect ice thickness. While none of this information is inaccurate, it can potentially be misleading to tourist understanding, as it is often suggested among news sources that global warming can lead to warmer sea temperatures (IPCC 2019). Additionally, the Glacier Lagoon website states that Jökulsárlón is the result of a warming climate (Glacier Lagoon 2019). These discrepancies among tour presentations may have contributed to post-assessment results about climate change understanding. The individuals strongly agreed that climate change is directly impacting the glacier they saw, which had decreased from the 96% of respondents that answered 'yes' when asked the pre-assessment question "do you believe climate change can affect the glacier you are seeing today." Lastly, since glacier tourism endeavors act as a valuable learning opportunity, it is "vital for tourism operators and guides to know well about correlative geographical knowledge" (Lui et al. 2006, 365).

There are noticeable limitations present during the Jökulsárlón Amphibian guided tour. Despite the informative speech about the glacier and the lagoon, many distractions are present. To begin with, several guests spent the entire tour taking photos

with their friends and family, even when the guide was speaking. Additionally, the guides had a short amount of time to present this information, and it was often done quickly. Other distractions included the boat motor and inclement weather. Despite small limitations, post-assessment results suggest that tourists did gain knowledge from the guided tour; therefore, boat tours at Jökulsárlón can be an effective way for tourists to gain brief knowledge on glaciers, but a more intimate and smaller tour may promote further and more developed understanding of glacier science and climate change.

5.5 Site Comparisons

This study compares three guided glacier tour types in Iceland to assess the outcomes and applicability of informal environmental education to teach about climate change and glaciers and to determine how the type of glacier tourism activity influences tourists' perceptions of these concepts. Each study site included in this study is very different in natural setting. For example, Sólheimajökull is an outlet glacier within the Mýrdalsjökull ice cap. Sólheimajökull is unique because of its connection to the Katla volcano, which often results in jökulhlaups on Sólheimajökull (Friis 2011). Additionally, Sólheimajökull continues to be at the forefront of studies on climate change, meaning that tourists may already be aware of climate change impacts to the glacier. Langjökull is unique, mostly due to its geographic location. While most Icelandic glaciers are located along the southern coast, Langjökull is more among the mid-west region; yet, it is still considered the second largest glacier in Iceland (Björnsson 2017). Tourists have the opportunity to not only stand atop this glacier and view the vastness of its beauty, but also can traverse inside the glacier, which is an

experience not accessible anywhere else in the world. Lastly, Jökulsárlón and its tourist attractions provide a unique opportunity for visitors to explore another glacier and its processes from a different perspective; the extent of the guided tour allows guests to witness its various processes and features up close and personal. Despite these differences in natural setting, pre- and post-assessment responses, coupled with semi-structured interviews, revealed that while there are some differences between each study site, learning outcomes were very similar among the three case study sites. In fact, due to the similarities between the three, after testing multiple parameters, there were no statistically significant differences in the number of responses based on both agreement and similar sample sizes. Therefore, statistical differences were based on visual descriptive statistics through graphs and tables. Semi-structured interview findings revealed there are many similar themes discussed among guides. Furthermore, Table 5.11 exhibits some noteworthy quotes pointed out by interviewed guides. Appendix F displays the full coding analysis of these themes and subthemes.

Table 5.11 Significant quotes from interviewed guides (Source: Created by author).

Major Themes	Quotes
Take Away Message	- "That nature can be sublime and that it is fragile." (Guide J, Personal Communication, 2019). - "Hopefully we can plant a seed of knowledge and a new perspective that they may not have thought of before. Many are coming to a place completely different from what they've ever seen before and that's good" (Guide K, Personal Communication, 2019). - "That this is not sustainable, and the glaciers are going away" (Guide L, Personal Communication, 2019). - "I feel like people should realize that this is not a good thing, and I'm not sure that a lot of people do" (Guide M, Personal Communication, 2019).
Tourism Knowledge	- "I did not realize how little concept people have of glaciers" (Guide J, Personal Communication, 2019). - "I feel that we should offer at least some information on the issue. There are signs all over the place that talk about how this happened but not a single one of them mention that this is an issue, and not just a fact" (Guide M, Personal Communication, 2019). - "And most of them seem to think they're all disappearing (glaciers), which is somewhat true. But most of our glaciers are too big to disappear" (Guide E, Personal Communication, 2019). - "They know some things, but we try to tell them about glaciers as much as possible. Most of the people appreciate it, so most of the people are interested in the glaciers. Some people want to just take photos, so that's fine too" (Guide H, Personal Communication, 2019).
Importance of Informing Tourist	- "First of all, we're just here to give people a good experience and have fun and see things. And you know, climate change can be a big political thing. And so, you get people from the states, or wherever, there are groups that don't believe in climate change and people that do. So, I'm not trying to start an argument or state any fact about climate change" (Guide D, Personal Communication, 2019). - "It's unavoidable" (Guide K, Personal Communication, 2019).
Changes in Tourism	- "Now there's a new generation we like to call the Instagram generation, they will come for a shorter trip. They want instant gratification with minimal effort" (Guide K, Personal Communication, 2019). - "There has been a dramatic increase in all glacier related activities in Iceland because it's cool and its fun, and of course it is. And it should be, and we should of course allow people to go. But I feel that people are taking for granted that this is only going to be an option for a couple of years and after that it's not going to be here anymore" (Guide M, Personal Communication, 2019).

One similarity among sites was found when asking tourists why they were visiting the attraction, with the top being for a ‘sense of adventure.’ This correlates directly with discussion on nature-based tourism by Kuenzi and McNeely (2008). As globalization has led to many individuals feeling a disconnect from nature; therefore, they feel an urge to “get back in touch with nature” and embark on a unique holiday experience, such as visiting mountains, or in this case, a glacier. Furthermore, glacier tourism, as a subset of nature-based tourism, has been described as a “return to nature” allowing opportunities for sightseeing, research, and education (Wang and Lan-Yue 2019). Other answers included sightseeing, to expand knowledge, and entertainment, which all also relate to these findings. Many visitors responded ‘yes’ when asking if mass tourism could impact the glacier they were seeing. This corresponds with Gössling et al. (2006) who found that 73% (n=184) of tourists at Zanzibar, Tanzania, believed that tourism could contribute to environmental problems; yet, Gössling et al. (2006) concludes that tourists do not realize their relationship to the environment and climate change. When analyzing pre- and post-assessment responses, tourists in Iceland differ from these findings, as they do seem to acknowledge their relationship to the environment. Figures 5.15 and 5.16 display the distribution of pre- and post-assessment results, allowing for visual comparison among each study site.

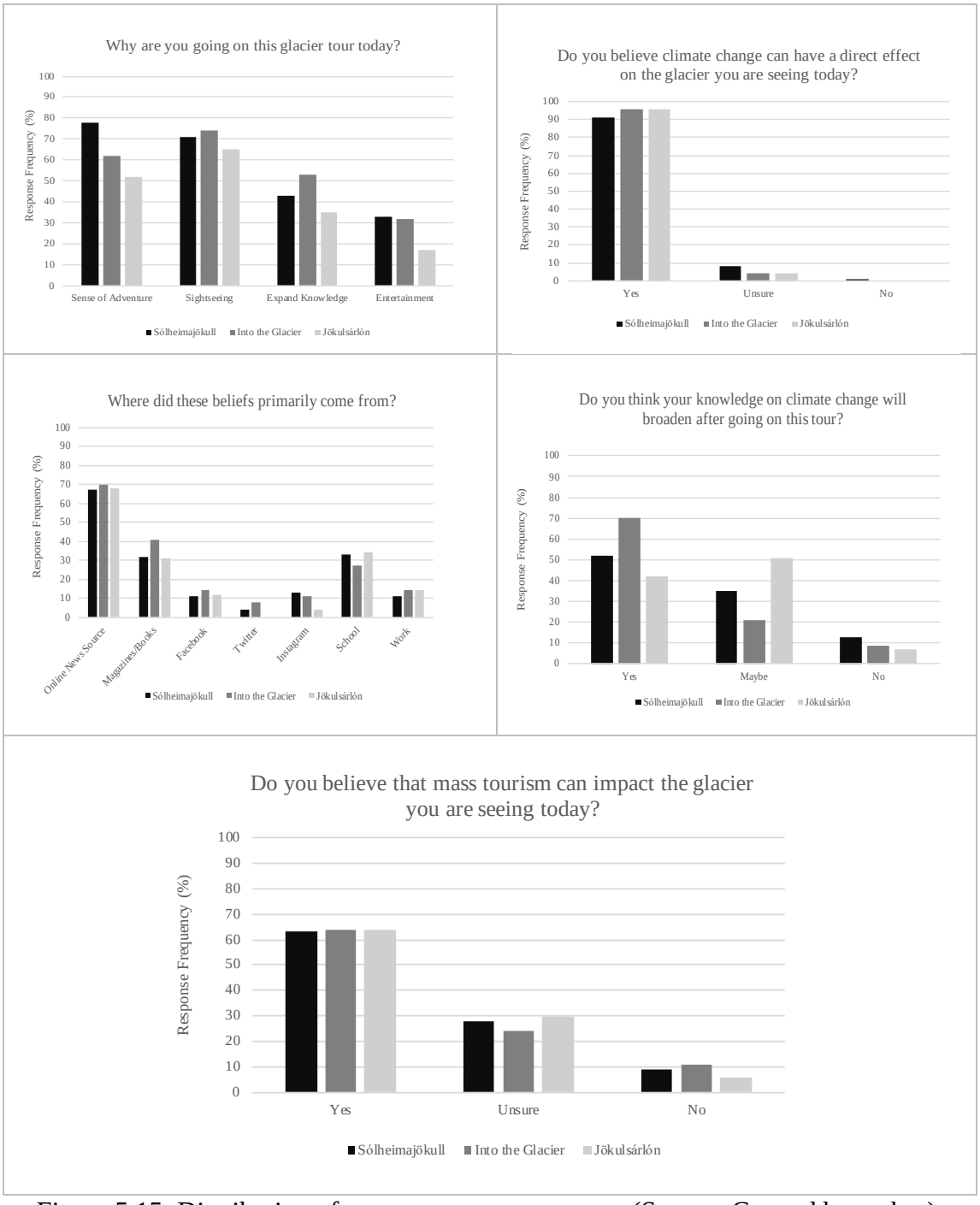
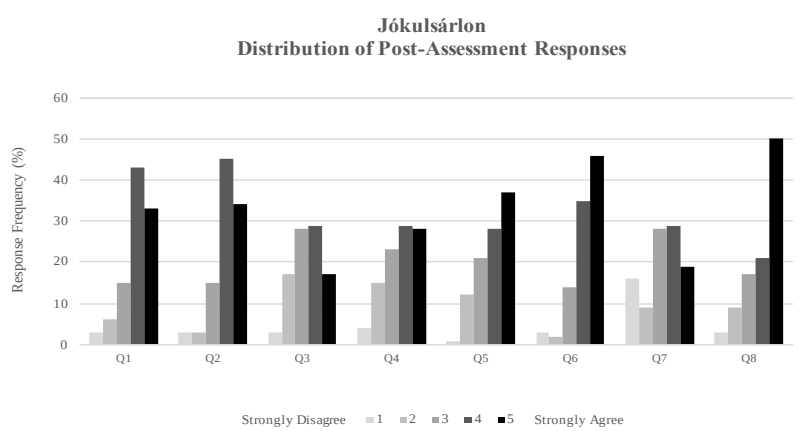
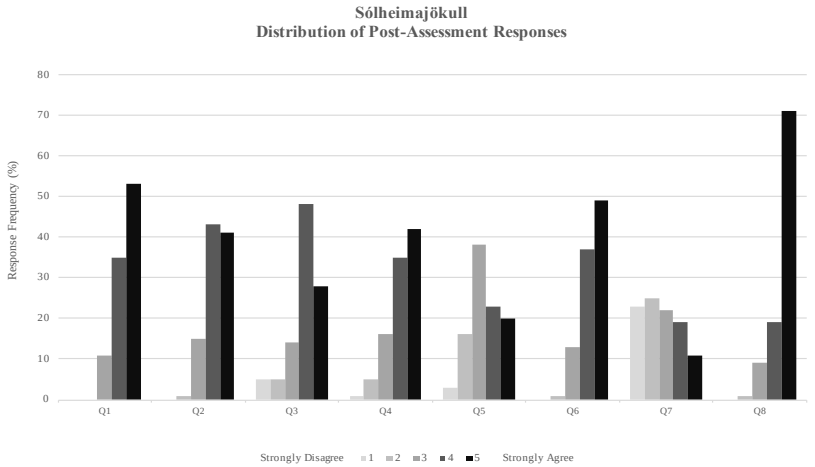
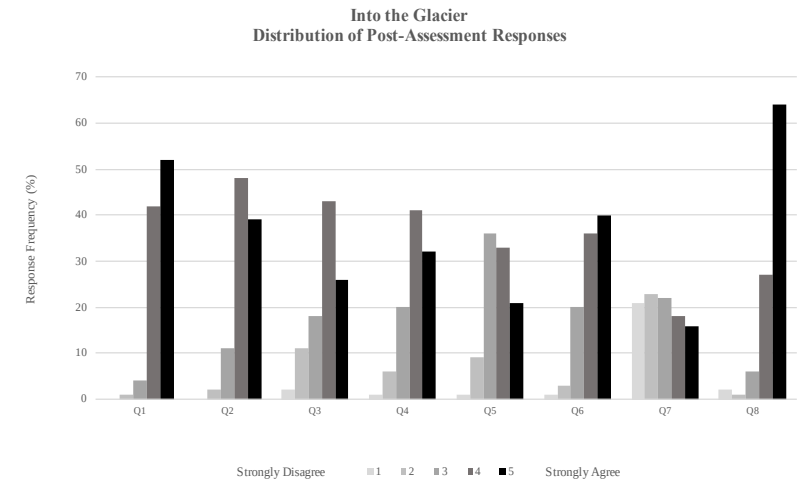


Figure 5.15: Distribution of pre-assessment responses (Source: Created by author).







Q1. My knowledge on glaciers **increased** after embarking on this tour.
Q2. I am interested in learning more about glaciers after going on this tour.
Q3. My knowledge on climate change has **increased** after going on this tour.
Q4. I feel more willing to learn and talk about climate change after going on this tour.
Q5. More scientific information should be included in this tour.
Q6. I want to learn more about Iceland's natural environment after going on this tour.
Q7. I believe that a different glacier experience would have taught me more about climate change.
Q8. I believe that climate change is having a direct impact on the glacier I saw today.

Figure 5.16: Distribution of post-assessment responses (Source: Created by author).

As mentioned throughout this chapter, tourists would occasionally write in a response regarding their reason to visit; nearly all write-in responses related to seeing the glacier before its gone, which emphasizes the prevalence of last-chance tourism in Iceland. It is stated in Lemelin et al. (2010) that potential loss of polar landscapes, specifically from climatic influences, has given many individuals around the world a rationale to visit them, as they may not be accessible in the future. This phenomenon has inadvertently resulted in economic benefits for the host country, due to an increased number of visitors. While there are benefits, climate change has been thought of as a double-edged sword for tourism, as it inevitably can result in destruction to the attraction, and there are large contributions of greenhouse gases from air travel (Meletis and Campbell 2007; Lemelin et al. 2010). Nonetheless, visitors in Iceland who are participating in glacier tours, for this reason, will develop some awareness on climate change and potentially return home with motivation to promote climate-responsible lifestyles among themselves and others around them.

The main similarity among pre-assessments is that an understanding of climate change is prevalent before the guided tour; this refutes the discussion by Wang et al. (2010), which stated that climate change is often ignored and rarely understood by glacier tourists. Yet, the past decade has witnessed increased understanding and advocacy for climate change understanding and may be more prevalent today. However, the extent of this understanding cannot be determined based solely on pre-assessment results. For example, at each site, many tourists believed climate change could impact the glacier they are visiting (Figure 5.14). When comparing the three study sites, this question regarding climate change impact resulted in markedly similar responses.

Additionally, responses suggest that this understanding is primarily from online news sources, with other responses mentioning social media outlets such as Twitter or Facebook. Since these sources are not always scientifically accurate or viable, glacier tours must present this type of information with as much accuracy and precision as possible. Despite this, post-assessment results suggested that most visitors developed a better understanding of climate change and the glacier they visited during their guided tour. In addition, assessment results show that most are interested in learning more about glaciers and climate change following their guided tour. As aforementioned, informal nature-tourism excursions often lead to positive educational outcomes, as "research suggests that such experiences can have an important influence on their attitudes and behaviors" (Ballantyne and Packer 2006). These findings suggest that any glacier tourism excursions in Iceland can be a useful informal outlet for enhancing and expanding visitor knowledge.

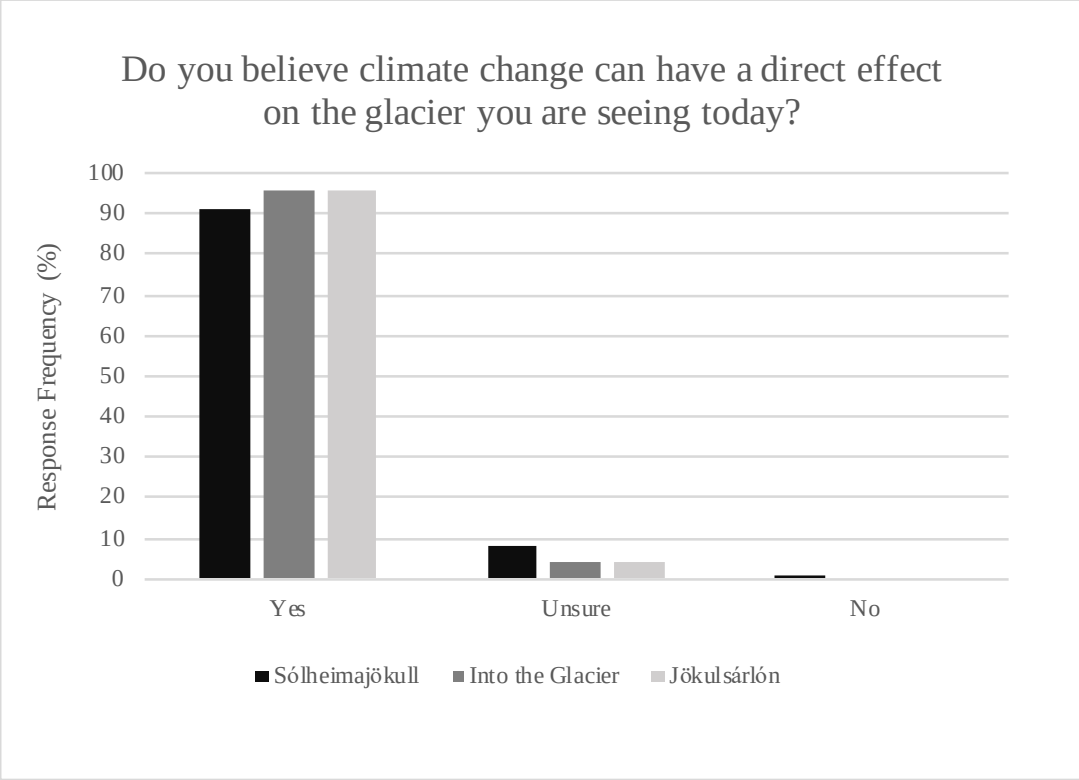


Figure 5.14: Comparison of pre-assessment question responses regarding beliefs on climate changes impact on the glacier tourists are visiting (Source: Created by author).

As discussed above, there was some discrepancy among guides beliefs on climate change, as some strongly believed in the occurrence, while others were hesitant of its full impact. These findings are similar to those found by Welling and Abegg (2019), who interviewed glacier guides in southern Iceland. This research discovered that many guides downplay climate change impact or perceive it as a common occurrence that will not affect operations. Access to the glacier was another common theme in semi-structured interviews, as guides must accommodate daily challenges and prepare for future environmental changes. Once again, this corresponds with the findings of Welling and Abegg (2019), which revealed that tourism operators in Iceland are already being affected by changes in the glacier environment, such as extreme

weather, glacial retreat, and a prolonged summer season. Welling and Abegg (2019) interviewed glacier guides to better understand adaptation measures when mitigating climate change impacts. Furthermore, in the study by Stewart et al. (2016), interview findings revealed that guides in New Zealand are concerned with tourists' access to the glacier. These findings are complementary to those revealed in this research, as they expand on the insights and perspectives of glacier guides in Iceland.

In conclusion, each of the tour-types chosen for this study is very different, yet results show that learning experiences were similar among sites. Each guided glacier tourism experience produced individuals with widened perspectives and an increased understanding of climate change and glaciers. No guided tour was found to be more educational than any other; each tour experience can play an important role in informing tourists and is an effective way to produce visitors that are aware and conscious of climate change and hopefully promote increased climate-responsible lifestyles. Despite some differences, various learning experiences among tours may be beneficial to travelers. If visitors attend more than one guided glacier tour, knowledge can be combined, and they will leave Iceland exponentially more educated about climate change and glaciers.

Chapter 6: Conclusions

This research analyzed changes in perceptions and understating of climate change following a guided glacier tourism experience in Iceland. Using a mixed-methods approach utilizing pre- and post-outcome assessments and semi-structured interviews, the research attempted to answer the following questions:

- How can glacier tourism activities, through the principles and practices of informal environmental education, be used as a venue through which to improve understanding of climate change science?
- In what ways, if any, are guided glacier tour experiences in Iceland communicating environmental topics to improve general knowledge of glaciers and their vulnerability to climate change and degradation by mass tourism activities?
- How does the type of glacier tour experience (e.g., hiking tours across a glacier, traversing through a glacier, or exploring a glacier lagoon) influence educational outcomes and visitor perceptions of climate change?
- In which ways do perceptions of educational outcomes of a glacier tour experience differ between glacier guides and visitors on their glacier tours?

Glacier tourism is an effective way to educate tourists on environmental topics such as climate change and glacier tourism. In total, 263 respondents completed both a pre- and post-assessment (see Table 5.12). Upon analysis of assessment results amongst study sites, both similarities and differences exist; yet, results suggest that learning outcomes were similar between sites. Furthermore, the distribution of responses between sites was so immensely similar that after testing multiple parameters, there was no statistical

difference among them. This alone suggests that regardless of the type of tour, visitors will leave a glacier tour attraction with a better understanding of scientific topics and a citizenry that will be more engaged in climate change conversations. Most glacier excursions in Iceland, including those discussed in this study, as well as others such as caving or ice climbing, by default, then automatically become a learning outlet. From findings in semi-structured interviews, it is impractical for guides not to mention climate change or provide some educational component, whether brief or descriptive. Due to this, glacier tourism activities are already an effective venue for improving tourist understanding.

Table 5.12: Total Collection of pre- and post-outcome assessments at each study site (Source: Created by author).

	Sólheimajökull	Into the Glacier	Jökulsárlón	**Total**
Participants that completed **both** pre- and post-assessments	79	90	94	**263**
Participants that completed **only the pre**-assessment	16	5	35	56
Participants that completed **only the post**-assessment	3	0	1	4
Semi-Structured Interviews	9	3	2	14

Assessment results and semi-structured interviews suggest that guided tours are attempting to improve general knowledge on glacier vulnerability due to climate change. Tourist beliefs prior to the guided tour suggested that they believed both climate change and mass tourism could affect the glacier they are visiting, suggesting that tourists are

already concerned about the health and longevity of the glacier. As post-assessment results were analyzed, these beliefs held following the tour as well; yet, from semi-structured interviews, guides are occasionally faced with communicating climate change to individuals that may be skeptical. A conversation with Guide J (personal communication, 2019) revealed that they conversed with individuals from the southern United States who questioned the ways in which the glacier melts. To mitigate conversations such as this, Guide J states:

> *In the conversations we sort of stick to the point even if someone's a hard-core skeptic. So, I don't say the earth is getting hotter, I say the glaciers getting smaller. I don't say the glacier is going to be gone in a hundred years I say this is the projected speed based on the past 20-year average and I add a bit of dramatic flair to it. I have only had once or twice someone come up to me after and try to get into an argument with me. The thing is, I have a lot of sympathy for skeptics. I understand the urge, I get the whole the skeptic thing. So usually I turn it into a discussion.*

As discussed in published literature, tour guides have the ability to act as a "pathfinder" in order to inform visitors effectively, promote environmental awareness, and produce mindful visitors (Cohen 1985; Moscardo 1996; McDonnell 2001). Due to this, even while interacting with skeptics, it is crucial that guides can communicate information that is not bias or inaccurate, as they can influence visitor experience through the information they present. As emphasized multiple times throughout the results and discussion, the pro-glacial zones often have extensive educational value (Welling et al. 2015). From findings in semi-structured interviews, it is impractical for guides not to mention climate change or provide some educational component, whether brief or descriptive. Therefore, tour operators could use this area to their advantage to

educate guests both before and after the guided tour through efforts such as signage or providing additional resources to those who are interested in learning more.

Assessment results suggest that learning outcomes are the same between the three guided glacier experiences. After tourists attended a guided glacier tour, there was an overwhelming amount of responses indicating that they believe climate change could impact the glacier they visited, along with responses suggesting that the tour attempted to inform tourists at some point during their visit. Furthermore, many glacier guides emphasized the importance of informing tourists to some degree, with some mentioning that they'd still like to include an entertainment aspect. Pro-glacial zones often have extensive educational value (Welling et al. 2015); therefore, tour operators could use this area to their advantage to educate guests both before and after the guided tour through efforts such as signage or providing additional resources to those who are interested in learning more. Furthermore, no matter the type of attraction, guides may find a way to inform guests, whether it is letting them hold a piece of ice from a lagoon or walking tourists next to a crevasse. Due to this, the three study sites are outlets that can both inform and entertain visitors.

Glacier sites, in general, become an informal learning opportunity as soon as you arrive at the destination. Coupling that with a guided tour, guests are bound to learn something during their travels. There is some disconnect between guide interpretation of tourists and visitors, as revealed through semi-structured interview findings and assessment analysis. For example, some guides believe that visitors are there for purely entertainment purposes; yet, assessment results suggest that some visitors want to learn more following their guided tour. In addition, post-assessment results suggest that guests

left with a better appreciation and understanding of glacier science; this corresponds with many guides hopes related to guests leaving their guided tour with a better appreciation of the natural environment.

While results among sites led to similar conclusions, biases and limitations were may have hindered results. For example, as noted in the Iceland Tourism Report (Oladottir 2018), the main reason visitors traveled to Iceland was its natural features. While no new reports have been gathered asking the same question, Iceland's natural environment still appears to be the main reason to travel to the country. Therefore, individuals participating in guided glacier tours will have some interest in participating in nature-based endeavors and likely have some understanding of environmental topics.

In the end, expected results will begin to address three guided glacier tours in Iceland in order to best to maximize the understanding of climate change and glacier science, while also entertaining guests to contribute to the development of an engaged citizenry in climate change conversations. Interviews with glacier experience provided further comprehensive insight on their personal challenges and perspectives encountered while being a glacier guide to begin to uncover techniques to enhance visitor learning and engagement through these tours. In short, the results of this study may help contribute to a better understanding of the crucial relationship between glacier tourism and environmental education. As a result, the two topics may be coupled together to promote better tourism planning and management in the glacier-tourism industry and increase scientific and environmental knowledge of glaciers in individuals participating in glacier tourism. There is a significant gap in the literature that combines environmental education and glacier tourism. While these topics have been recognized

and studied individually, no in-depth study has been conducted on these topics together. This research will be the first of its kind to couple two expanding scholarly fields, environmental education and glacier tourism, and emphasize the critical relationship between them.

6.1 Recommendations for Development

Based on the results of this research, the three studied glacier excursions in Iceland are an effective outlet for informing tourists on climate change and general glacier science; yet, through pre- and post-outcome assessments and semi-structured interview findings, future glacier attractions may refer to the following recommendations. As seen at each glacial attraction site, there was signage located along pro-glacial zones, which provides background information on the glacier and natural environment. Through observational findings, guests often stopped to read what was on these signs. As stated throughout, pro-glacial zones offer extensive educational value (Welling et al. 2015) and should be present at any type of tourist attraction.

Each of the focused study sites prepared for tour presentations in slightly different ways. For example, guides at Sólheimajökull were required to attend a training course prior to leading guests atop the glacier, while those at Into the Glacier were provided a guidebook filled with information regarding the landscape. In contrast, tour recordings at Jökulsárlón revealed that guides were given a semi-structured script. Each of these methods were effectively communicated environmental topics; yet, it could be beneficial for operating companies to combine these methods in order to inform and entertain guests in the most valuable way. When analyzing semi-structured interview

transcriptions, guides across all sites seemed comfortable with their training; yet, as discovered from the Jokulsarlon boat tour transcriptions, minimal training may result in misconceptions between guide presentations. Therefore, if guides were provided training courses prior to starting their position, coupled with an informational booklet and a semi-structured script, an effective attraction would be sculpted. More specifically, guide training may consist of formal classroom settings that teach guides on safety, history of the glacier, and tourism trends within the country, followed by physical training activities to prepare guides for on-site tours fully.

One major misconception discovered during data analysis was the disconnect between guide perceptions of tourists and visitor educational outcomes. As discussed, semi-structured interview transcriptions revealed that some guides believe visitors are coming to the attraction for purely entertainment; yet, pre- and post-assessment results reveal that guests do want to learn more following their guided tour, with 'entertainment' being the lowest response when asking guests their reason for visiting the attraction. Furthermore, despite there being a wide variety of ages and education levels among demographics, assessment results reveal that all guests participating in guided tours want to learn at some point during their experience. When asking Guide H (personal communication, 2019) about their observations of tourist perceptions, they responded, "most of the people appreciate it, so most of the people are interested in the glaciers. Some people want just to take photos, so that's fine too." Multiple other occasions expressed through interviews and outside communication suggested that guides believe tourists do not care for a learning experience, but the opposite is true. Therefore, when developing management plans and scripts for future glacier excursions,

its crucial to consider ways which enhance visitor learning outcome and assure guides are aware of this interest from tourists.

6.2 Future Research

This research attempted to better understand tourist perspective and understanding of climate change during a guided glacier tour; it acts as a preliminary basis for understanding how tourists learn through a guided tour, following informal learning practices. While results helped answer research questions and gain insight into these perspectives, future work could develop a more detailed understanding. For example, demographic data suggests that older age groups participated in the Jökulsárlón boat tour, as it is less physically demanding compared to hiking atop Sólheimajökull. Therefore, learning outcomes may be different than a younger demographic, which may already have background knowledge on climate change. Furthermore, although learning outcomes among sites were similar, visitors seeing the inside of the glacier may have developed a different understanding than those traversing across a lagoon or hiking on a glacier. Future research could focus more specifically on demographics at each site and compare trends between age groups, education level, or gender. As seen in this study, a wide array of demographics were represented in only two weeks; if one were to double this time conducting research, nearly all corners of the globe could be represented.

Future studies may also look to develop a knowledge-based assessment that would assess learning outcomes before and after a guided tour. By doing this, the researcher may develop a better understanding of the level of detail presented during a

tour, and how well the tourists are absorbing this information. This may also be extended to selecting a handful of focus groups that would attend and be assessed following multiple different guided glacier tours across Iceland to understand how learning outcomes and information presented during tours differ among attractions.

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APPENDIX A
Pre-Assessment

What tour are you taking today?

Please circle your response to the following questions.

1. Why are you going on this glacier tour today? (Circle all that apply).
   Sense of adventure
   Sightseeing
   Expand knowledge and perspectives
   Entertainment
   Other? _____

2. Do you believe climate change can have a direct effect on the glacier you are seeing today?
   YES UNSURE NO

   If **yes or no**, where did these beliefs primarily come from? (Circle all that apply).

   Online news source Magazine/Book Facebook Twitter
   Instagram School Work
   Other? _____

3. Do you believe that mass tourism can affect the glacier that you are seeing today?
   YES UNSURE NO
4. Do you think your knowledge on climate change will broaden after going on this tour?
   YES MAYBE NO

APPENDIX B

Post-Outcome Assessment

Age_____ Gender_____ Country of Origin_____

Occupation_____ Education Level_____

For each of the following, circle which number represents your experiences today. 1= strongly disagree, 2=disagree, 3= unsure, 4= agree, 5= strongly agree.

1. My knowledge on glaciers **increased** after embarking on this tour.

   1 2 3 4 5

2. I am interested in learning more about glaciers after going on this tour.

   1 2 3 4 5

3. My knowledge on climate change has **increased** after going on this tour.

   1 2 3 4 5

4. I feel more willing to learn and talk about climate change after going on this tour.

   1 2 3 4 5

5. More scientific information should be included in this tour.

   1 2 3 4 5

6. I want to learn more about Iceland's natural environment after going on this tour.

   1 2 3 4 5

7. I believe that a different glacier experience would have taught me more about climate change.

   1 2 3 4 5

8. I believe that climate change is having a direct impact on the glacier I saw today.

   1 2 3 4 5

Provide a short response for the following questions.

1. Why did you decide to take this tour today?

2. Did your experience meet your expectations? If not, what changes could be made to improve future tours?

APPENDIX C

Glacier Guide Semi-Structured Interview Questions

1. What qualifications were required for you to obtain this job?
2. Where did you gain your background knowledge on glaciers?
    - What other knowledge have you gained since becoming a guide?
3. What observations have you made on tourist's overall perceptions and understanding of glaciers?
4. What challenges have you had to overcome in regard to any landscape changes?
    - Has this had an impact on the tours in anyway?
5. What should the biggest take away message be after embarking on a guided glacier tour?
6. Do you think informing the tourists on environmental topics is an important part of a guided tour?
    - How can it be improved (or should it be improved)?
7. What changes have you seen in glacier tourism overall since you began working as a guide?
    - Has visitor growth (or decline) had an impacted on the quality of the tour?

Age_____ **Gender_____** **Country of Origin_____**

Occupation_____ **Education Level_____**

APPENDIX D
Respondent Demographics

Age	Gender	Country	Occupation	Education Level	Tour
25-34	F	United States	Attorney	Doctorate	Sólheimajökull
24-34	M	United States	Physician	MD	Sólheimajökull
24-34	M	United Kingdom	Civil Servant	-	Sólheimajökull
24-34	F	Gibraltar	Company Administration	Degree Level	Sólheimajökull
34-44	F	United States	Legal	College	Sólheimajökull
34-44	F	United States	Event Planner	Bachelor of Arts	Sólheimajökull
25-34	M	Gibraltar	Police Constable	-	Sólheimajökull
18-24	W	Denmark	Gap Year	High School	Sólheimajökull
25-34	M	United States	Architect	Master's	Sólheimajökull
25-34	M	United States	Dietician	Master's	Sólheimajökull
34-44	M	United States	Physician	Post-Grad	Sólheimajökull
34-44	F	United States	Teacher	Master's	Sólheimajökull
25-34	F	United States	Marketing Director	Bachelor's	Sólheimajökull
24-34	F	United States	Nurse	BSN	Sólheimajökull
24-34	M	United States	Writer	Doctorate	Sólheimajökull
45-64	F	Australia	Business Performance Manager	Master's	Sólheimajökull
45-64	M	Australia	IT Manager	Technical	Sólheimajökull
25-34	M	United States	Engineer	University	Sólheimajökull
45-64	F	United States	Accountant	MBA	Sólheimajökull
25-34	F	United States	Graduate Student	Master's	Sólheimajökull
25-34	F	United States	CEO	Bachelor's	Sólheimajökull
35-44	F	United States	Education	Doctorate	Sólheimajökull
25-34	M	United States	Blogger	Master's	Sólheimajökull
-	-	-	-	-	Sólheimajökull
45-54	F	United States	Finance	Doctorate	Sólheimajökull
-	M	Singapore	-	Degree Level	Sólheimajökull
25-34	F	United States	Attorney	Graduate	Sólheimajökull
25-34	M	United States	Doctor	Post-Grad	Sólheimajökull
25-34	F	United States	-	College	Sólheimajökull
35-44	M	United States	Law Enforcement	AA	Sólheimajökull
-	-	-	-	-	Sólheimajökull
45-54	M	Germany	IT	-	Sólheimajökull
25-34	F	United States	Vet	Doctorate	Sólheimajökull
34-44	F	Israel	BI	High School	Sólheimajökull

35-44	F	Israel	Lawyer	LLB	Sólheimajökull
25-34	M	United Kingdom	Bookkeeper	Master’s	Sólheimajökull
25-34	F	United Kingdom	HEI Admin	Bachelor’s	Sólheimajökull
35-44	F	Israel	Tech	-	Sólheimajökull
25-34	M	Hong Kong	Accountant	University	Sólheimajökull
35-44	M	Belgium	Clerk	High School	Sólheimajökull
25-34	F	United States	Marketer	Bachelor’s	Sólheimajökull
45-54	F	United Kingdom	Health	University	Sólheimajökull
45-54	M	United Kingdom	Factory Work	High School	Sólheimajökull
25-34	F	United States	Pharmacist	Doctorate	Sólheimajökull
25-34	F	United States	-	-	Sólheimajökull
25-34	F	United States	Planner	-	Sólheimajökull
-	F	-	-	-	Sólheimajökull
25-34	M	United States	Police Officer	Bachelor’s	Sólheimajökull
25-34	F	United States	Nurse	Bachelor’s	Sólheimajökull
-	-	-	-	-	Sólheimajökull
-	-	-	-	-	Sólheimajökull
55-64	M	United States	-	-	Sólheimajökull
45-54	M	United States	Education	Master’s	Sólheimajökull
25-34	F	Taiwan	NGO	Master’s	Sólheimajökull
25-34	F	Taiwan	Social Worker	-	Sólheimajökull
25-45	F	Taiwan	NGO	Master’s	Sólheimajökull
-	M	Poland	-	-	Sólheimajökull
-	-	-	-	-	Sólheimajökull
45-54	-	-	-	-	Sólheimajökull
-	-	-	-	-	Sólheimajökull
-	-	-	-	-	Sólheimajökull
-	-	-	-	-	Sólheimajökull
25-34	M	Hong Kong	-	-	Sólheimajökull
-	-	-	-	-	Sólheimajökull
35-44	F	Australia	Farmer	University	Sólheimajökull
35-44	F	Australia	Public Servant	Tertiary	Sólheimajökull
25-34	M	Spain	-	-	Sólheimajökull
25-34	F	Spain	Education	University	Sólheimajökull
25-34	F	United States	Human Resources	Bachelor’s	Sólheimajökull
25-34	M	United States	Software Development	Bachelor’s	Sólheimajökull
55-64	F	United States	Retired	University	Sólheimajökull
25-34	M	United States	Entrepreneur	University	Sólheimajökull
35-44	F	Poland	-	-	Sólheimajökull

-	-	-	-	-	Sólheimajökull
25-34	F	France	-	University	Sólheimajökull
45-54	F	South Africa	Editor	Post-Grad	Sólheimajökull
35-44	F	Poland	Tax Advisor	Master’s	Sólheimajökull
25-34	F	Poland	-	Master’s	Sólheimajökull
-	-	-	-	-	Sólheimajökull
25-34	M	United States	Engineer	Bachelor’s	Into the Glacier
35-44	F	Canada	Public Accountant	Master’s	Into the Glacier
-	-	-	-	-	Into the Glacier
25-34	F	United States	Insurance	Bachelor’s	Into the Glacier
55-64	F	United States	Retired	Bachelor’s	Into the Glacier
25-34	F	Italy	Teacher	Bachelor’s	Into the Glacier
55-64	M	United States	Retired	College	Into the Glacier
55-64	M	Portugal	Driver	-	Into the Glacier
35-44	M	South Africa	Account Director	Tertiary	Into the Glacier
45-54	M	United States	Writer	University	Into the Glacier
55-64	M	Spain	Forwarder	Primary	Into the Glacier
55-64	M	Spain	Forwarder	Primary	Into the Glacier
35-44	M	United States	Attorney	Law School	Into the Glacier
25-34	M	South Africa	Yachting	High School	Into the Glacier
25-34	M	United Kingdom	Tourism	Bachelor’s	Into the Glacier
45-54	F	United States	Management	Bachelor’s	Into the Glacier
45-54	F	Spain	Account Manager	University	Into the Glacier
35-44	F	South Africa	-	-	Into the Glacier
25-34	F	South Africa	Consultant	Postgraduate	Into the Glacier
55-64	F	United Kingdom	-	Matrix	Into the Glacier
35-44	M	Canada	-	Post-Secondary	Into the Glacier
45-54	F	Germany	-	-	Into the Glacier
-	-	-	-	-	Into the Glacier
-	-	-	-	-	Into the Glacier
35-44	M	United Kingdom	Banker	Secondary	Into the Glacier
55-64	M	Hong Kong	GM	University	Into the Glacier
25-34	F	Lithuania	Receptionist	Bachelor’s	Into the Glacier
55-64	M	China	Retired	Secondary	Into the Glacier
18-24	F	Slovakia	Receptionist	High School	Into the Glacier
35-44	M	France	Artist	-	Into the Glacier
35-44	M	Portugal	-	University	Into the Glacier
25-34	F	Portugal	-	University	Into the Glacier
45-54	M	Hong Kong	Doctor	Postgraduate	Into the Glacier

25-34	M	Australia	Seaman	University	Into the Glacier
35-44	F	United Kingdom	-	-	Into the Glacier
-	-	-	-	-	Into the Glacier
25-34	F	Hong Kong	-	-	Into the Glacier
25-34	F	Germany	Teacher	Master's	Into the Glacier
25-34	F	Australia	Stake Holder	University	Into the Glacier
45-54	F	China	Retired	Secondary	Into the Glacier
25-34	F	Spain	-	University	Into the Glacier
35-44	M	Spain	-	Formation Professional	Into the Glacier
-	-	-	-	-	Into the Glacier
-	-	-	-	-	Into the Glacier
45-54	F	Canada	Nurse	University	Into the Glacier
25-34	F	Spain	Designer	University	Into the Glacier
45-54	M	South Africa	Management	University	Into the Glacier
55-64	F	Canada	Management	-	Into the Glacier
35-44	M	United States	Government	Bachelor's	Into the Glacier
45-54	F	Germany	Product Manager	University	Into the Glacier
65+	M	Canada	Retired	Postgraduate	Into the Glacier
55-64	F	United Kingdom	-	-	Into the Glacier
55-64	M	United Kingdom	Management	A Level	Into the Glacier
65+	M	Hong Kong	Retired	University	Into the Glacier
55-64	M	Hong Kong	Technician	University	Into the Glacier
45-54	F	Taiwan	-	-	Into the Glacier
35-44	M	Hong Kong	Sales	-	Into the Glacier
35-44	F	Hong Kong	Secretary	Master's	Into the Glacier
55-64	F	Taiwan	Teacher	University	Into the Glacier
18-24	F	Taiwan	-	-	Into the Glacier
-	-	-	-	-	Into the Glacier
25-34	F	Australia	-	-	Into the Glacier
25-34	M	Canada	Farmer	University	Into the Glacier
35-44	F	Taiwan	-	-	Into the Glacier
-	-	-	-	-	Into the Glacier
55-64	F	United States	Nurse	University	Into the Glacier
25-34	M	China	Engineer	Master's	Into the Glacier
65+	M	United States	Retired	-	Into the Glacier
-	F	-	-	-	Into the Glacier
25-25	F	Hong Kong	Auditor	Bachelor's	Into the Glacier
35-44	M	United States	Engineer	Master's	Into the Glacier

65+	M	United States	Photography	Bachelor's	Into the Glacier
25-34	F	United States	Nurse	Bachelor's	Into the Glacier
35-44	F	United States	-	Bachelor's	Into the Glacier
35-44	M	Peru	Hair Stylist	University	Into the Glacier
-	-	-	-	-	Into the Glacier
-	M	Hong Kong	Surveyor	University	Into the Glacier
25-34	F	Hong Kong	-	-	Into the Glacier
-	-	-	-	-	Into the Glacier
25-34	M	Holland	MRA	Master's	Into the Glacier
25-34	N	Netherlands	Associate	Master's	Into the Glacier
35-44	F	Netherlands	Director	University	Into the Glacier
45-54	M	Netherlands	Banker	University	Into the Glacier
25-34	M	Slovakia	Finance	Master's	Into the Glacier
65+	M	Spain	Medicine	Doctorate	Into the Glacier
25-34	M	Netherlands	Finance	University	Into the Glacier
45-54	F	Netherlands	Office Manager	HBO	Into the Glacier
45-54	M	Netherlands	Painter	Master's	Into the Glacier
25-34	M	Netherlands	Finance	Master's	Into the Glacier
-	M	Netherlands	Cooperate Finance	University	Into the Glacier
25-34	M	Spain	Doctor	Doctorate	Jökulsárlón
18-24	F	Spain	Nurse	Master's	Jökulsárlón
55-63	F	Taiwan	Retired	University	Jökulsárlón
-	-	-	-	-	Jökulsárlón
25-34	M	United Kingdom	Farmer	-	Jökulsárlón
25-34	F	United Kingdom	Vet	Degree	Jökulsárlón
35-44	M	Italy	Business Owner	Master's	Jökulsárlón
-	-	-	-	-	Jökulsárlón
34-44	M	France	Laboratory	Bachelor's	Jökulsárlón
25-34	F	France	Travel Agent	University	Jökulsárlón
18-24	M	United States	Distribution	Bachelor's	Jökulsárlón
18-24	F	United States	Dancer	Bachelor's	Jökulsárlón
35-44	M	United Kingdom	Contractor	Doctorate	Jökulsárlón
45-54	F	United States	Senior Director	Master's	Jökulsárlón
18-24	M	France	-	-	Jökulsárlón
25-34	F	France	Designer	Master's	Jökulsárlón
18-24	F	Spain	Social Worker	University	Jökulsárlón
25-34	F	France	Employed	Master's	Jökulsárlón
25-34	M	France	-	Master's	Jökulsárlón
25-34	F	Poland	Administration	Master's	Jökulsárlón

25-34	F	United Kingdom	Administration	University	Jökulsárlón
-	-	-	-	-	Jökulsárlón
25-34	M	Romania	Programmer	Bachelor’s	Jökulsárlón
25-34	F	Romania	IT Specialists	Master’s	Jökulsárlón
25-34	F	Romania	Programmer	Master’s	Jökulsárlón
25-34	M	Romania	Programmer	Master’s	Jökulsárlón
25-34	M	Netherlands	-	University	Jökulsárlón
25-34	F	Netherlands	Optician	University	Jökulsárlón
35-44	F	France	-	-	Jökulsárlón
45-54	M	Israel	Lawyer	-	Jökulsárlón
-	-	-	-	-	Jökulsárlón
-	-	-	-	-	Jökulsárlón
-	-	-	-	-	Jökulsárlón
25-34	F	Poland	Data Analyst	University	Jökulsárlón
35-44	F	Poland	Quality	MSC	Jökulsárlón
18-24	M	China	Student	Bachelor’s	Jökulsárlón
18-24	M	China	Finance	Bachelor’s	Jökulsárlón
-	-	-	-	-	Jökulsárlón
-	M	Columbia	-	-	Jökulsárlón
35-44	F	Columbia	-	Master’s	Jökulsárlón
-	-	-	-	-	Jökulsárlón
35-44	F	United States	Attorney	JD	Jökulsárlón
35-44	F	Singapore	-	University	Jökulsárlón
45-54	M	India	Software	Master’s	Jökulsárlón
-	-	-	-	-	Jökulsárlón
-	-	-	-	-	Jökulsárlón
45-54	F	Philippines	Employed	University	Jökulsárlón
-	-	-	-	-	Jökulsárlón
-	-	-	-	-	Jökulsárlón
-	-	-	-	-	Jökulsárlón
-	-	-	-	-	Jökulsárlón
-	-	-	-	-	Jökulsárlón
25-34	F	Hong Kong	-	-	Jökulsárlón
25-34	M	Hong Kong	Employed	University	Jökulsárlón
-	-	-	-	-	Jökulsárlón
18-24	F	Mexico	Student	University	Jökulsárlón
25-34	F	Mexico	Lawyer	Master’s	Jökulsárlón
25-34	F	Germany	-	-	Jökulsárlón
25-34	M	New Zealand	Chef	Bachelor’s	Jökulsárlón

-	-	-	-	-	Jökulsárlón
18-24	M	India	Geologist	Master's	Jökulsárlón
25-34	F	China	Civil Servant	Master's	Jökulsárlón
25-34	M	China	Civil Servant	Bachelor's	Jökulsárlón
-	-	-	-	-	Jökulsárlón
25-34	M	United States	Military	University	Jökulsárlón
54-64	M	United States	Broker	Master's	Jökulsárlón
18-24	F	United States	Vet	Bachelor's	Jökulsárlón
35-44	F	United States	Tax Director	Bachelor's	Jökulsárlón
65+	F	United States	Retired	Bachelor's	Jökulsárlón
-	-	-	-	-	Jökulsárlón
-	-	-	-	-	Jökulsárlón
-	-	-	-	-	Jökulsárlón
25-34	M	Spain	Doctor	Master's	Jökulsárlón
45-54	M	South Africa	-	Post Grad	Jökulsárlón
45-54	F	South Africa	Editor	Post Grad	Jökulsárlón
25-34	F	Russia	-	-	Jökulsárlón
25-34	F	Russia	-	-	Jökulsárlón
25-34	-	Taiwan	-	University	Jökulsárlón
35-44	F	Taiwan	Finance	Master's	Jökulsárlón
35-44	M	Taiwan	-	Master's	Jökulsárlón
-	-	-	-	-	Jökulsárlón
65+	F	United States	Retired	Bachelor's	Jökulsárlón
65+	F	United States	Retired	Post Grad	Jökulsárlón
65+	F	United States	-	-	Jökulsárlón
65+	F	United States	Retired	Master's	Jökulsárlón
65+	F	United States	Retired	Post Grad	Jökulsárlón
65+	F	Germany	-	University	Jökulsárlón
65+	M	United States	Farmer	Bachelor's	Jökulsárlón
65+	F	United States	-	-	Jökulsárlón
65+	M	United States	Physician	Doctorate	Jökulsárlón
18-24	F	Germany	-	High School	Jökulsárlón
25-34	M	Germany	-	-	Jökulsárlón
-	-	-	-	-	Jökulsárlón
65+	F	United States	Retired	-	Jökulsárlón

**Dash indicates that information was not provided by tourist.*

APPENDIX E

Glacier Guide Demographic Details

	Age	Gender	Country	Education Level	Tour
Guide A	**25-34**	M	Iceland	Adventure Guide Certificate	Sólheimajökull
Guide B	**35-44**	F	Hungary	Master's	Sólheimajökull
Guide C	**18-24**	M	Iceland	Bachelor's	Sólheimajökull
Guide D	**18-24**	M	Iceland	High School	Sólheimajökull
Guide E	**35-44**	M	Iceland	Bachelor's	Sólheimajökull
Guide F	**55-64**	M	Iceland	Technical School	Sólheimajökull
Guide G	**25-34**	M	Australia	Bachelor's	Sólheimajökull
Guide H	**35-44**	F	Poland	Master's	Sólheimajökull
Guide I	**35-44**	M	Poland	Master's	Sólheimajökull
Guide J	**25-34**	M	Iceland	Master's	Into the Glacier
Guide K	**35-44**	M	Iceland	Master's	Into the Glacier
Guide L	**25-34**	M	Iceland	Technical School	Into the Glacier
Guide M	**18-24**	F	Iceland	High School	Jökulsárlón
*Guide N	**-**	-	-	-	Jökulsárlón
*Guide O	**-**	-	-	-	Jökulsárlón
*Guide P	**25-34**	M	Belgium	Master's	Jökulsárlón

** indicates guides that were recorded during a guided tour.*

APPENDIX F

Glacier Guide Coded Interview Analysis

Glacier Guides: Themes and Sub-Themes	Sólheimajökull	Into the Glacier	Jökulsárlón	Frequency (Total)
Qualifications				
Speak 1+ language		2	2	4
Training Courses	5		1	6
Obtained Background Knowledge				
No previous knowledge	1	1	1	3
Growing up in Iceland	3	1	1	5
School	5	1		6
Previous tourism job	4	1	1	6
Knowledge Gained				
Almost everything I know	2		1	3
How glaciers work	3	1	1	5
Glacial Retreat	4			4
Environmental Challenges				
Glacial retreat	2			2
Access	5	3	2	10
Daily changes	4		2	6
Seasonal challenges	2	2		4
Size of tour groups	5	1		6
Timing	1	2		3
Take Away Message				
Understanding glaciers retreat and advance	4		1	5
Global warming impact	4	1	1	6
Learn something and have fun	3	1		4
To respect nature	3	1		4
Tourist Knowledge				
Mixed understanding; some who have no idea, others who know a little	6	2	1	9
Don’t know what a glacier is	5	3		8
Only there for photos	2	1	1	4
Importance of Informing Tourists				
Not crucial, could include a little (it’s their vacation)	6		1	7
Important	4	3	1	8
Should emphasize climate change more	1		1	2
Changes in Tourism				
Increased visitors	6	1	2	9
Increase in glacier tourism			1	1
Changes in demographics	1	3		4
Tourist awareness	2	1		3
Structure of tourism	2	1		3
Decreased visitors	2			2