WEATHER DATA GAMIFICATION

A Thesis

by

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ABSTRACT

Climate change is an important issue for public policy. Unfortunately, although there are volumes of data about climate change, many members of the public are informed about the issue by politicized interpretations of the data. This is an impediment to planning policies and strategies to counter the impact of climate change, and identifies a need for climate awareness in the public.

This thesis explores using *gamification* to motivate people to learn about long term trends in climate data. As a model for this edutainment activity, we choose a medium that engages millions of players to learn about large sets of data - Fantasy Sports. Fantasy sports have been shown to increase the player's knowledge and understanding about the domain of the sport being played. With the huge amount of weather data available, we have designed and developed a fantasy weather game. People manage a team of cities with the goal of predicting weather better than other players in their league, and in the process gain an understanding of the weather patterns and climate change trends for those cities. We do a user-study to evaluate our application and prove its feasibility.

An evaluation of the fantasy weather game indicates that the game had the desired effect of causing players to explore weather data in more detail. The evaluation also pointed out a number of potential improvements to the current prototype. Overall, the evaluation supports using the model of fantasy sports to motivate people to learn more about weather and climate data.

DEDICATION

This thesis is dedicated to my loving parents, my younger sister, my elder sister and my brother in law for motivating me, to my wonderful friends for their unconditional help and to Dr. Frank Shipman for constant inspiration and guidance.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER I

INTRODUCTION AND LITERATURE REVIEW

A fantasy sport is an interactive game derived from the output of a real sport (statistics and records of athletes, coaches and teams), where the fantasy sport participant plays the role of the owner or the manager of a team. The players can play out their 'fantasy' of being the one to draft an 'ideal' team and make all the decisions for that team. The player starts by forming a team by virtually drafting actual sport athletes into the team. Then later, he can change the team composition by exchanging and trading players. Moreover, he has to deal with player injuries just as a real team owner would in the real sport. As in real life, there are constraints on the fantasy sport. For example, players have limited amount of virtual currency to form and manage the team. They can only select a limited number of athletes of a certain skill or skill level. And there are deadlines to form the team. The player has to stay within these bounds. When the real sports season starts, the fantasy sport engines monitor the statistics of the athletes in real life, and based on their performance in the actual sport, the owner of the fantasy team gets awarded points. As the season progresses, the fantasy sport player has to make adjustments to the team as required, like keeping the injured players out of the team, adding or removing players of a particular skill type to perform well in the upcoming games, etc., in order to maximize the points. Using these points, different team owners compete virtually. There are tournaments, leagues, brackets and winners, just like real sports.

1.1 Evolution of fantasy sports

The origin of fantasy sports dates back to as early as 1950's. Wilfred Winkenbach, a limited partner in the Raiders football team, had a concept idea about a golf game where the players would pick actual golf-players, add up their scores of each week and compare. Following that, he also devised a baseball game where baseball players were picked, and their statistics were compared against each other [1]. 1962 was when the groundwork for the first fantasy sport – fantasy football – was laid. Wilfred Winkenbach, along with Scotty Stirling (Reporter for The Beat), Bill Tunnell (Raiders Public Relations agent) and George Ross (Sports Editor) created a set of rules and blueprints for a game where players could draft actual football players into imaginary teams and compete in leagues based on statistics with their friends for a reward. A participant earned just 25 cents for a passing touchdown, $2.50 for kickoffs returned for touchdowns and a whopping $5 for a touchdown by a defensive lineman. The Greater Oakland Professional Pigskin Prognosticators League (GOPPPL) was the first fantasy league, made official in 1963. This league consisted of 8 teams and one commissioner – Winkenbach – who presided at all meetings, and a Secretary who kept the league records and data and was responsible for the fees and prize money. The teams were not public and were restricted to football related professionals. To be a member, one had to be affiliated with a professional football team or have a direct relationship to football in journalistic capacity, or have had purchased or sold 10 season tickets for the Oaklands 1963 season. The drafting and the scoring was all done on paper. Figure 1 shows a scan of an original GOPPL drafting scorecard. The GOPPL was well received by the people

who participated. Scotty Stirling said that "*Competition was fierce. Friendships were destroyed. There were some divorces. But guys used to try like hell to get in.*" [1-3].

	Mousalmas	Roos	Wiul	Blum	Carmona	Conn	Tunnel	Clack
OFFENDS	Shofner	Collins	Ravole	Art Powell	Dial	Ditka	Taylor	Burford
	Turner	Kochek	Coogill	Clanton	B Miller	Duvall	Phillips	Dowler
	Capolett	Walton	Alworth	Retzlaff	A Thomas	Arbanas	Brown	Warlick
	Romeo	Howton	Ferguson	McGee	Kramer	Orr	Norton	Robinson
BACKS	Hennigan	Lincoln	Mason	Gifford	Mitchell	Conrad	Daniels	T Brown
	Clark	Barr	Stowe	Tom Moore	Haynes	Lowe	McDougld	Colclough
	Perkins	Phillips	Carey	Mingo	Dubenion	Maynard	L Moore	Hoak
	McElhenny	Kiic	Cauoon	Bull	Jackson	Lisbon	Tobin	Lewis
BACKS	Blanda	Dawson	Tobin Rote	Flores	Kemp	Tittle	Johnson	Ryan
	Unitas	Parilli	Tarkenton	Starr	Wade	Brown Ed	McCormick	Wood
BACKS	Johnson	J Brown	Gannon	Gilchrist	Triplett	Tolan	McClinton	Taylor
	Smolinski	Spikes	Mathis	J D Smith	Billy Joe	Miller	Marconi	Webster
BACKS	Mingo	Martin	J. Cramer	Blanda	Cappolleti	Grola	Chanoler	Michaels
	Brooker	Mercer	Ed Khayat	Davis	Spikes	Blain	Guesman	Yoho
	Shannon	Suci	Woodson	Gibson	Adderly	Lincoln	T Brown	Jackson
	Gannon	Chick	Chas Mitchell	Lowe	Roberson	Christie	Javuie	Frazer
BACKS	Taylor	Williams	Grayson	Morrow	Willie Wood	Woodson	Lynch	Zeman
	Chick	Banfield	Coudoula	O'Hauly	Suci	Krakoski	Harris	Gibson
DLINEM	Hussman	Jelacic	Faison	Costa	Ladd	Eisenhauer	Sestak	P Allen
	Dee	Brown	Petrick	Mays	McMurtry	Schmidt	Bell	Autwine

Figure 1. Scan of a GOPPPL fantasy football drafting scorecard from 1963 [3].

In the 1960s, Willam Gamson (Harvard University Sociologist) started a *Baseball Seminar* game where colleagues would form teams that earned points based on batting average, runs batted in, earned run average and wins. This continued in the University of Michigan where some professors played the game. In 1979, *Rotisserie Baseball* was officially created by Daniel Okrent, who was a student in this university. He had learned the basic version of the game at the University, and he pitched his idea to his friends at the *La Rotisserie Francaise* restaurant. The names *American* and *National*

were taken, so they used the name *Rotisserie Baseball*. The rules were similar to the football version, except this one was open to friends and friends of friends instead of just professionals [4]. They would draft baseball players in imaginary teams to accumulate points and the team with the maximum points would win [4-6]. In these early versions of the game, direct communication (mail, telephones, direct conversation) was required on a weekly basis between the players and the league commissioners and secretaries, so that the teams could be updated, the scores calculated and shared back with the players.

Thus the fantasy sports started, evolved and kept growing in popularity. With the arrival of networked computers and the Internet, communication between people has become easier. Websites and Emails have made it easier than ever to share data with huge masses of people. Today, Internet access is not just limited to computers. Smart-phones and tablets make it easy for the people to go online anytime and almost anywhere. This also makes it easy to stay connected and to share and retrieve information. With these advances in technology and modern conveniences, the fantasy Sports industry has reached new horizons and has seen tremendous growth in popularity and market size. Today, Fantasy sports are prominently played through the Internet [7].

Figure 2. Fantasy sport logos of some major companies.

4

According to the Fantasy Sports Trade Association, 34 million people (age > 12) played fantasy sports in just the United States of America in the year 2011, and this number is growing at a fast rate. In the 4 years from 2007 to 2011, participation has grown by over 60% [8]. Today, several technology companies and sport franchises like ESPN, NFL, Yahoo, CBS, etc. have taken up fantasy sports. Figure 2 shows the fantasy logos of some of these companies. They provide people with a platform where people can register, join league and compete with friends and other people from all over the world in their favorite fantasy sport. The prize money also has increased. For example, CBS fantasy football offers prizes from $39.99 to $2500.00 for different types of game play [9].

Fantasy sport games are available for most of the popular mainstream sports. Table 1 shows participation of the fantasy sport players in different fantasy sports. Fantasy football enjoys the largest player base.

Sport	Players*
NFL football	72%
Baseball	37%
Racing	24%
Basketball	20%
Golf	13%
Hockey	12%
Soccer	7%

Table 1. Fantasy league participation by sport [8, 10].
(* Ages 12 and up. Several players play in more than one sport)

1.2 Impact of fantasy sports

With such a strong presence, it is no surprise that the fantasy sports have a direct or indirect impact on us. Companies and sport franchises continue to invest more and more money into this game genre, and participants are spending more resources than ever on their fantasy teams. From the actual sporting events to the economy of the country, the effect of Fantasy Sports is notable.

1.2.1 Fantasy sports and media use

The first university baseball game was broadcasted on television in the year 1939 by NBC [11, 12]. The first NFL game broadcasted on television was in 1956 by CBS, which was only available to selected television markets [13]. Since then, the media industry has seen huge growth. Today sports fans enjoy 24/7 access to sports entertainment through several dedicated sport networks like CBS, Fox, ESPN, etc. These networks sign deals worth billions of dollars with sports leagues for broadcast rights. Currently Fox and Turner sports have a contract with MLB (Major league Baseball) with a value of over $6 billion for the next years, from 2013 to 2021 [14]. With the huge sport-fan base watching live sporting events, the television networks make profits through advertisements. But, today television faces stiff competition from other media forms, especially the Internet [15, 16]. The Internet has become the face of fantasy sports. It allows easy communication between the players and the administrators through emails. Websites give the ability to easily provide detailed statistics and stream event videos, which players can look up anytime and anywhere, unlike television, which has

the constraint of time and location [7]. Television networks use these aspects of the Internet to their advantage and Fantasy sports plays a big role in this objective.

Fantasy sports are able to keep the sport audience more engaged in the television sporting events. Usually, people exhibit support for their favorite sports by watching their home-team games. But their interest might wane if the team performs poorly in the first half season to the point that they may not watch the games in remaining half. The scene is different for fantasy sport participants. Since the fantasy sport participants have a sense of ownership towards their virtual team, which is comprised of athletes from more than one real team, their viewership tends to be more stable. Fantasy team owners are thus more likely to watch games in which the team members of their team play, in addition to the home-team games. Research conducted by Randle & Nyland in 2008 proved that more the people get involved in fantasy sports, the more they are likely to follow that sport through media aside from the Internet. There is a positive correlation between fantasy sport participation and watching sports or sports highlights [17]. Fantasy baseball participants are estimated to watch between 1.12 - 2.85 more games per week on television which is 73% more than the people who do not play fantasy sports. In the case of the NFL, Fantasy football participants watch between 0.59 - 1.07 more games per week, which is 35% more than non-players [18]. Not only this, but the NFL games with high percentages of NFL players in fans' fantasy football leagues showed higher ratings on the television channels as compared to other NFL games [19, 20]. A higher television rating has an economic benefit to the network and eventually the sport league benefits when it negotiates its next broadcast rights contract.

Furthermore, television sport networks have their own websites with different versions of fantasy sports where people can sign up and compete. These are incorporated to complement the television broadcasts to generate more interest in live television sporting events. This *intersection* of television and fantasy sport play has been a subject of study for improving marketing strategies [21]. As an example, ESPN had a 90-minute fantasy baseball preview in March 2012 with a panel of experts who analyzed statistics and made predictions on player performance and pitching draft strategies.

Figure 3. Sirius XM launched a 24/7 sports radio channel [22].

Sirius XM, a major satellite radio broadcast service provider, launched a fantasy sports radio channel in 2010, which covers various fantasy sports and talks about news, analysis and statistics [22]. Figure 3 shows the logo of this channel. With smartphones and tablets, online radio services are becoming common today. TuneIn, an online radio and podcast service, offers several fantasy sport stations like RotoExperts, Fantasy Focus and NFL Fantasy Live.

1.2.2 Fantasy sports and actual sports

When the relationship between NFL attendance and fantasy football participation was studied, it was found that more participation in fantasy football leads to increase in

the game attendance. A fantasy football player attends between 0.22-0.57 more games per year than the average non-player [23]. In a similar study conducted on fantasy baseball, it was found that fans who are fantasy baseball players are 41% more likely to attend at least one MLB game per year as compared to the non-fantasy participants. Specifically, the average fantasy participant attends between 0.47-1.38 more games per year relative to their nonparticipant equals [24].

Thus, fantasy sport participants are more likely to attend games on average than nonparticipants. In addition to more attendance in the sport events, fantasy sports also directly affect the athletes of the sport. With fantasy sports getting more and more coverage, athletes are becoming more aware of their fantasy-sport fan following. Former Giants running back, Tiki Barber said: "*In a game solely designed around the team concept, it's nice to have some individual recognition every now and then, Fantasy football does that. It's already the most popular sport, but it's a way for people to delve into the sport and get to know the individual players, which they probably wouldn't have an opportunity to do otherwise*" [25].

Popular New York quarterback Eli Manning said: "*Guys come up and say, 'I need you to throw about four touchdowns this week - I've got you in fantasy'*" [25].

Matt Stover, former Ravens Placekicker said: "*You get letters, they say, 'Hey, man, you've got to kick well this week, and I will win the Super Bowl.' You are really more connected with the fans. They follow you more. I think it is an ingenious idea, because it wasn't really in existence when I got in the league*" [25].

9

Colts Linebacker, Cato June said: "*Playing New England, I can't be happy with him throwing a TD pass, but in the back of my mind, I'm like, 'Yeah, I just got six points in my fantasy league*" [26].

1.2.3 Fantasy sports and economy

With over 34 million players just in the USA and several big companies (ESPN, CBS, etc.) investing in the game, the fantasy sports has an annual economic impact estimated at $4.48 billion across the sport industry [27]. This huge potential market created by fantasy sports contributes to the country's economy. In a study conducted in 2008 by IPSOS, it was found that fantasy sport participants had an average household income of $94,000 [28]. Several fantasy sport websites offer a paid membership to players who are willing to pay in exchange for more detailed analysis, statistics and expert opinions. Many fantasy sport fans are dedicated to stay up to date and go for the paid options. On average, a fantasy sport player spends $95 on league related costs (fees, challenges, more material, etc.) over a 12 month period [10]. When the spending habits for some categories were tracked, it was noted that fantasy sport participants spent more than the sports fans alone and the general population. These categories included beer and fast food, air travel, credit cards, video game systems, sports magazine readership, etc. [28]. Table 2 shows the spending habits of fantasy sports participants compared with sport fans and general population.

In the past 30 days,	Fantasy	Sports	General
Beer	73	52	47
Other alcohol	68	52	48
Fast food	92	87	86
Soft Drinks	94	91	89
In the past 12 months			
Flown on an airline	52	42	42
At least once per month			
Read a sports magazine	63	49	48
General			
Own a computer	97	95	96
Have a cable/satellite service	95	91	90
Use a cell phone	93	89	88
Own athletic shoes	90	80	77
Own a video game system	58	42	40

Table 2. Spending habits of fantasy sports participants compared with sport fans and general population (all numbers are percentages) [28].

Advertising is a major source of revenue for several media. In a survey conducted to study fantasy football for marketing strategies, 63% of people recalled seeing an advertisement from one of the five major fantasy advertisers researched [21]. Thus an increase in fantasy sport participation leads to greater revenue for the media channels.

Another example of the effect of fantasy sports on economy is the new type of insurance companies which offer insurance to fantasy sports teams and team players. The fantasy team owners have an option to insure the athletes in their fantasy team. There are different types of insurance options which can be used by the fantasy player. For example, if an insured athlete gets injured in a game in that season, then the owner gets back the fee he paid [29, 30]. Furthermore, in case of any conflicts or disputes in the fantasy leagues, websites like http://sportsjudge.com/, http://fantasyjudgment.com/ offer lawyer services just for the fantasy sports domain [31].

Figure 4. The cover of 'The Hollywood Reporter' of the August 2011 issue [32]

Taking all this into account, an average fantasy football participant spends $467.60 per year, and an average active fantasy football participant makes $60,000 to $100,000 per year [33]. The Hollywood Reporter calls Fantasy football a 'recession proof obsession' [34]. Figure 4 shows the cover of the August 2011 issue of 'The Hollywood Reported.

With the amount of time and money people are spending on fantasy sports, it continues to expand, draw more players, more corporate investments, advertisers and thereby creating more of an economic impact.

1.3 Motivation behind fantasy sports

The easy access to Internet and the love for sports drives people to play fantasy sports. The Internet is available to a huge mass of population today. 2.4 billion people had access to Internet in June 2012 [35]. Characteristics of the Internet are different from the traditional broadcast media like television, radio, etc. In addition to content delivery, information retrieval, etc., the Internet can be more personal and offer more interactivity and customization [36-38]. This aspect is exploited by the fantasy sport websites to cater to the specific needs of their users and make fantasy sports more engaging and personal [39]. Furthermore, with fantasy sport participants potentially spending more resources towards their teams, as discussed in section 1.2, companies consider these people to be a lucrative market segment. In 2008, a total of $500 million dollars was given out as prizes in Fantasy Sports [40]. This is a huge motivation to play the game.

But it's not just the reward that makes people join fantasy leagues across the Internet. Living a virtual life as a team manager or a head coach is another major motivation along with the competition that fantasy sports provide [39]. Here people can live out their fantasies of 'outperforming actual team managers'. Besides these fundamental motives, people also play fantasy sports for hedonic experience, escape, arousal, bonding with friends or family, and social interaction [39, 41-44]. Fantasy sport

players are categorized into different types [44]. Each type has a different motivation to play the game, and spends different amount of resources towards the game.

1.   Casual Players - These players don't spend much time/money and are a big chunk of the total Fantasy sport participants. Their goal is to have fun, have social interaction and enjoy.

2.   Skilled Players - These players have a more high regard for the competition and are more involved. They spend more time and money and form the Second Largest percentage of fantasy sport participants. Their goal is motivation to win, social interaction and enjoyment.

3.   Isolationist Thrill seekers - These players have the longest participation duration, and spend almost the same time and money as casual players. Their goal is arousal and negative on social interaction.

4.   Trash talkers – These players spend minimal time and money. They are motivated by arousal and goal is social interaction and dominance assertion.

5.   Formatives - These players have the shortest participation duration. They spend more time and money in general but have lowest regard for Fantasy sports. They enjoy information and statistics pertaining to scoring and thrill of victory. This category is overall complex to understand.

By understanding the motivation behind why people play fantasy sports, businesses can cater to the specific needs of the market. Sports marketers have studied fantasy sport motivation to improve sports marketing [43]. We think it is important to understand the motivation because fantasy sports have become a medium connecting

millions of players. Being able to keep so many people engaged this medium can potentially be utilized for *mass education*.

1.4 Introduction to climate change

Ever since human societies have industrialized, various human activities have produced large amount of greenhouse emissions from multiple sources that have had an effect on the climate. Climate change is important because it affects the planet and its entire ecosystem. As per the latest available climate assessment report filed by Intergovernmental Panel on Climate Change (IPCC) in 2007 (AR4) [45], global average surface temperatures have increased by $0.74 \pm 0.18\,°C$ from the year 1906 to 2005.
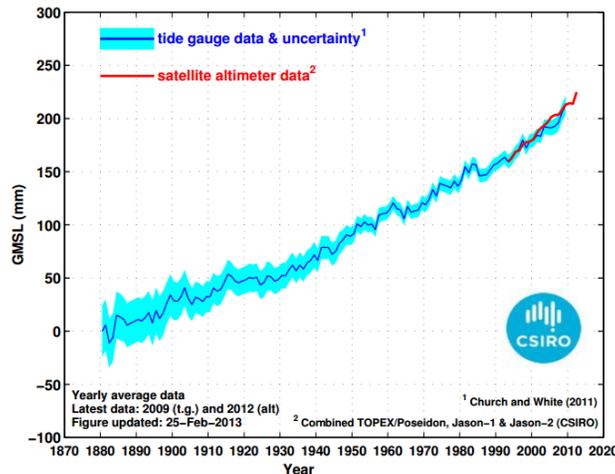
Figure 5. Global Mean Sea Level (GMSL) from 1880 to 2012 [46].

According to the U.S. State of the Climate report released by the National Ocean and Atmospheric Administration (NOAA) National Climatic Data Center, 2012 was the warmest year on record in the contiguous U.S. where the temperature of the lower 48 states was the highest so far [47-49]. As a result of increasing temperatures a global

15

warming is observed, which leads to the rise of sea level. Through the 20th century the global sea level rose at an average rate of 1.7 mm per year, and the oceans have risen 4-8 inches over the last hundred years [50]. Figure 5 shows the sea level rise through a graph. With the current trends, IPCC projects that the global sea level would rise by 18 to 59 cm (7 to 23 inches) by 2100 [51]. The observed general glacier retreat in the warming tropical Andes has increased significantly. Figure 6 shows the diminishing Chacaltaya Glacier through 1940, 1982, 1996 and 2005. This glacier was expected to last until 2015, but instead it lasted only until 2009.

Figure 6. The Chacaltaya glacier, Bolivia, from 1940 to 2005 [52].

As the global temperatures increase, the oxygen levels in the ocean are seen to be depleting. A 2008 study compared oxygen levels in the tropical ocean from 1960 to 1974

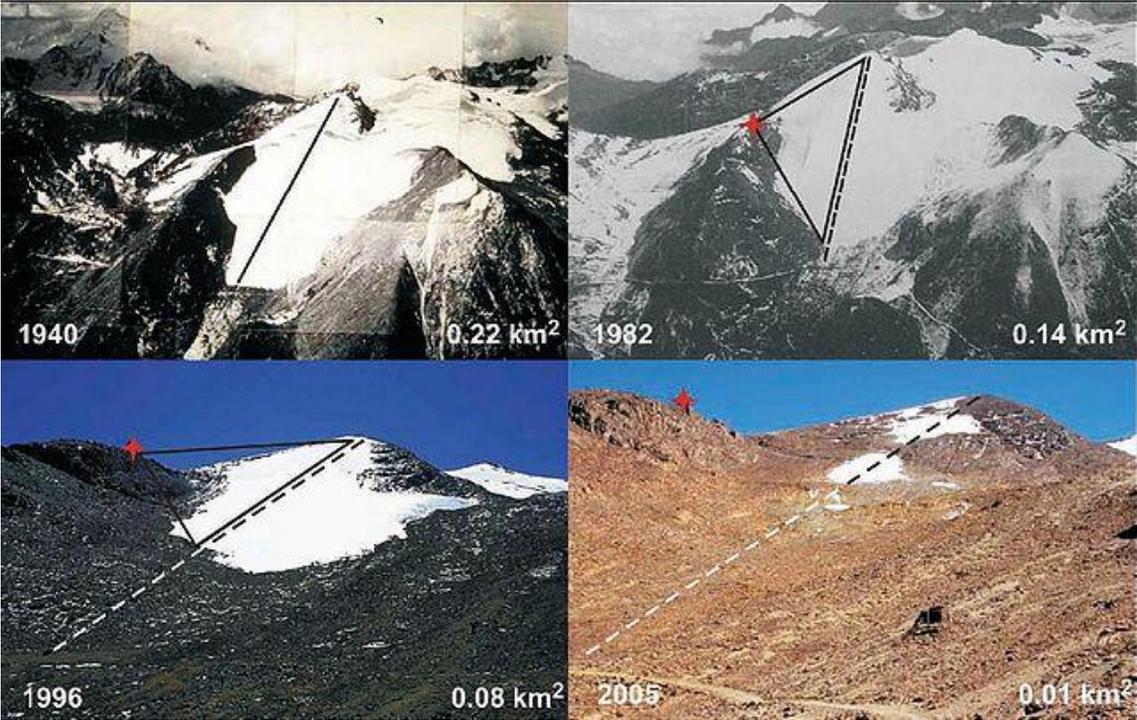with the levels in the same area from 1990 to 2008 [53]. The study found that with only some exceptions, most places showed lower levels of oxygen. The area of the global ocean without enough oxygen for animals to survive had expanded by 4.5 million square kilometers, about half the size of the United States. This has a direct impact on life under water - only the species which can survive in water with low-oxygen levels will thrive - which directly affects the sea food industry. With the summers getting hotter, there has been an increase in wildfires. 2012 has been declared as the worst year for wildfires, with nearly 7 million acres of land charred in just the first 8 months of the year [54].

Due to the changing climate, events like droughts and floods, glacier melting, etc., will likely be more extreme which will possibly affect national security. A report on the Council on Foreign Relations compiles such possible effects [55]. The prospect of large scale climate refugee flow across borders is a concern for governments. The first people to bear the brunt of the climate-change impact were the inhabitants of Carteret Islands, a group of islands formed from coral in the Pacific. In the year 2009, 2700 inhabitants were evacuated. They are referred to as the 'first climate change refugees' [56]. A direct impact can affect the critical military bases, thus diverting national defense resources. With the sea ice melting, by the year 2050, the Northern Sea route and the Northwest Passage would be available for water transport, providing a shorter alternate route to the Panama Canal between Europe and Asia. This issue is feared to be caught up in interstate disputes over control of those waters. Also some areas in the same region are believed to contain petroleum reserves which add to the possible tension over the

control of the area [55]. The increasing sea levels pressures 250 million people in the world indirectly where as 30 million may be affected by droughts [57].

Greenhouse-induced cooling of the outer atmospheric layers is expected to prolong the effect of ozone-depleting gases. This will increase levels of Ultraviolet radiation (UVR) reaching some parts of the Earth's surface [58]. This is undesirable as UVR impacts human health adversely in several ways, from the immune system to the effect on the skin. At the same time, an increase in the atmospheric temperatures will influence clothing choices and possibly the time spent outdoors. This will potentially increase the exposure to the UVR in some regions. In addition to the UVR impacts on the human health, climate change has caused an earlier onset of the spring pollen season in the Northern Hemisphere [52]. This is important for people with allergies and sensitivities to pollen. Allergenic diseases caused by pollen have experienced some change in seasonality [59]. These issues are expected to compound over time, becoming more serious in magnitude [60]. Shortage of fresh water and vulnerability to climate changes in China will have an impact on the country as well as global economy. Africa's vulnerability to climate change in addition to its existing problems makes the continent more susceptible to humanitarian disasters [55].

All these factors caused by climate change directly impact the economy. A 2006 study conducted by scientists and economists from the Department of Ecology, State of Washington, indicate significant impact on the State of Washington, USA economy. The study concludes that the cost of fighting wildfires may increase by 5% from the current costs i.e. by $78 million per year by 2020. Water conservation costs could exceed by $8

million. Public health costs are also expected to increase, along with tourism and recreation losses. Dairy revenues may decline by $6 million due to the effect on cattle. There are several more effects explained in the study, and the cumulative effect on the economy is much more larger than the individual impacts [61]. It is estimated that by the year 2030, the cost of climate change and air pollution combined will rise to 3.2% of global GDP, with the world's least developed countries forecast to bear the brunt, suffering losses of up to 11% of their GDP. Major economies will not be left alone as climate change could cause the United States, China and India to collectively incur enormous losses that by the year 2030, totaling to about 2.5 trillion dollars in economic costs [57, 62].

Climate Vulnerable Forum Chair representative Sheikh Hasina, Bangladesh said in the 67th session of United Nations General Assembly [63]: "*One degree Celsius rise in temperature is associated with 10% productivity loss in farming. For us, it means losing about four million metric tonnes of food grain, amounting to about US$ 2.5 billion. That is about 2% of our GDP. Adding up the damages to property and other losses, we are faced with a total loss of about 3-4% of GDP. Without these losses, we could have easily secured much higher growth.*"

Michael Zammit Cutajar, former executive secretary of the UN Framework Convention on Climate Change, said [63]: "*Climate change is not just a distant threat but a present danger – its economic impact is already with us.*"

CHAPTER II

RESEARCH MOTIVATION

2.1 Public perspective on climate change

Climate change is a complex process and not easy to comprehend. It is not a single event like a thunderstorm or a hurricane. Climate change is a slow process subject to variability and fluctuation and takes place over a period of time. The measurements to gauge this phenomenon have to be taken over long periods of time spread over distant geographical areas [64]. The main causes behind it are invisible and data shows that the effects of climate change are not uniform through the different regions of our planet and are geographically unevenly spread [65, 66]. Simple interpretations of climate change, such that the planet will uniformly be warmer or cooler, drier or wetter, etc. result in people noticing data that does not match the interpretation and questioning whether climate change is occurring at all, or gives false understandings of climate change.

Earlier studies in social psychology show that for a given task or subject, people make judgments or arrive at decisions based on personal experiences [67, 68]. For instance developing dislike to a food eaten just prior to symptoms of food poisoning, etc. The same logic is applicable to the public perception of climate change. This type of learning leads to a tendency where the public gives more weight to recent events than the distant events. As a result, the people tend to overreact to recent events and underestimate or ignore the future consequences of it [69].
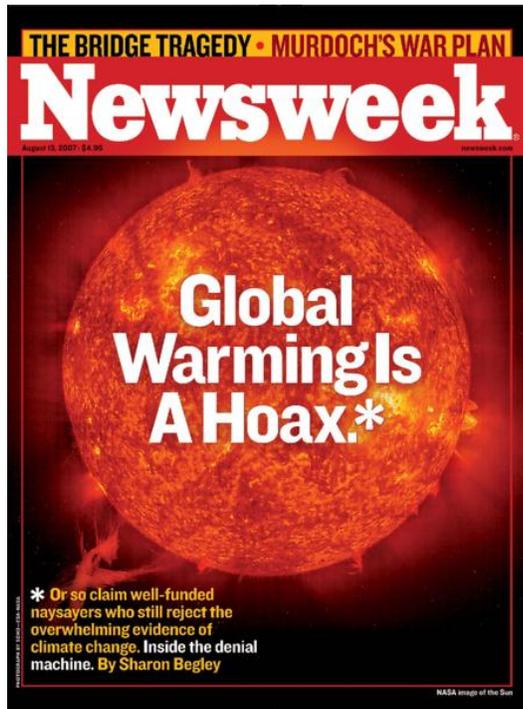
Figure 7. The cover of August 13, 2007 issue of the 'Newsweek magazine' [70].

For example, summer heat in late 1980s piqued public fears about global warming. People had formed their opinion based on that particular summer experience [71-73]. In 2010 the record snowfalls along the East Coast in the Washington D.C. area gave rise to several reports which used this fact in favor of skepticism over global warming [69]. In the last few years, a sudden boom in jellyfish population was observed. First this was attributed to climate change and global warming. Later it was found that the earlier was a false alarm and there was no global increase in the jellyfish population [74, 75]. Figure 7 shows the cover of August 2007 issue of 'Newsweek magazine' which discussed this topic.

When a study was conducted on a diverse sample of US residents in order to gauge how people conceptualize the global climate change and make judgments about it, the researchers determined that the knowledge and understanding of many people about climate change was incorrect [76]. People in this study interpreted climate change based on their perception of weather, i.e. personally experienced variables like temperature, rainfall and pollution, and not on the actual long term climate. Another similar study confirmed the previous result [77], where people had difficulty distinguishing between climate and weather. The study found out that people hold a consistent and rigid set of beliefs regarding these terms, which is inconsistent with the scientific definitions. National Snow & Ice Data Center (NSIDC) defines weather as the condition of the atmosphere over a short period of time, and climate as the behavior of the atmosphere over long periods of time. Understanding climate change involves analyzing long term weather averages and weather extremes [78]. Further studies showed that wrong personal beliefs greatly affect the concern and willingness of the people to take action [79].

In another series of psychological studies, it was seen that the less people know about an issue, the less they care about finding more about it. The study states this as the *'ignorance is bliss'* approach to social issues [80]. In this study most of the participants who were unknowledgeable about an issue like economy, energy consumption and the environment, avoided negative information about that issue. The Huffington Post used this to describe 'Why we are all confused about climate change' [81].

As the climate change directly or indirectly affects everything from the society to the economy, it is important to have a correct idea about how the climate is changing in different regions. Confusions and misunderstandings about climate change can be harmful because people form their opinion of policies related to climate change based on these (mis)understandings. These policies that are formed in order to address the climate change (regarding fuels, taxes, emissions, etc.), amount to expenditure of trillions of dollars. For intelligent debates and discussions in order to shape these policies, people need to clearly understand the related terms and concepts.

2.2 Why fantasy sports?

In the earlier described *'ignorance is bliss'* study [80], the authors state that "*Beyond just downplaying the catastrophic, doomsday aspects to their messages, educators may want to consider explaining issues in ways that make them easily digestible and understandable, with a clear emphasis on local, individual-level causes*". This is applicable in our case. While it is important to educate people about the climate change, it should possibly be done in a step by step approach which would be more 'digestible' to the population. This is not a trivial task which can be accomplished simply by writing articles or publishing papers to convince people and motivate them to learn about it.

In Achievement Goal Theory [82], the basic assertion is that achievement goals influence the quality of cognitive self-regulation. This means that people are more actively engaged in the learning and analyzing something if they are working towards a

23

goal, i.e. to achieve something. Also it is known that people who know more about a particular domain generally understand and remember better than those with only limited knowledge of that background. People who perform strategic processing of information do better than those who do not. Through these aspects, people enhance their knowledge about the domain in the process [83-85]. If people know more about a topic, they are more likely to go into the details of that topic [80].

People like to play games. 50% of the U.S. population plays games on a daily basis through gaming consoles, personal computers, browsers, tablets and/or smartphones. In a 2011 survey, of over 2000 people from the United States, 55% said that they would work for a company which uses games as a way to increase productivity [86]. With the increasing availability and usage of the Internet, online games are becoming very popular as they offer benefits and conveniences like social connectivity, leisure, competition, interactivity and flow experience [87].

Thus, we think that a good medium to educate people about a given task would be the one that combines the entire above criterion. This is where the Fantasy Sports come in. 'Fantasy sports' is a gaming genre and satisfies the above criterion. So we have chosen to '*gamify*' the weather data using the concept of fantasy sports.

Gamification is the use of elements traditionally thought of as game-like or "fun" to promote learning and engagement [88, 89]. Recently the word gamification is gaining much attention and is a growing trend in fields like education and marketing. Gamification uses game mechanics to engage the participants in activities and ideas in which they would otherwise not be involved. It involves using the MDA (Mechanics,

Dynamics and Aesthetics) framework for engagement [90]. Gamification is a good way to encourage learning because many concepts in gamification are based on educational psychology, and are techniques that designers of instruction, teachers, and professors have been using for years. For instance, simple ideas like assigning points to activities and encouraging collaboration on projects have been central to education and are used in gamification. The use of gamification provides another layer of interest over conventional education and thus forms a new way of weaving together the conventional ideas into an engaging space that both motivates and educates the learners [89]. Thus when implemented properly, gamification can be a powerful tool to engage, inform and educate.

Fantasy games are a good candidate for gamifying non-gaming contexts. They have a goal, where the players play because of the motivation to compete and win. Since they are also a form of online gaming, they are accessible to a wide population. Furthermore, to compete and win in Fantasy sports, domain knowledge is certainly beneficial and involves strategic processing of sports and athlete statistics, requiring dynamic changes to the gameplay over the season of the sport being played. Thus we choose fantasy sports as a means to try and educate people about the trends of climate change.

Fantasy games are already in use in domains other than sports for educational purposes. Fantasy game players process sport statistics without even realizing that they are doing math. This fact was used to create a middle school curriculum that uses fantasy gameplay to teach math to students [91]. Here students draft and manage fantasy teams

of professional athletes, very similar to a fantasy sport team. The teams earn points based on their statistics from real games. The students compete against each other through their teams with others, with the goal of accumulating the maximum number of points. Students track their team's progress by reading statistical summaries from newspapers or websites and each week they have to 'calculate' the points earned by their players. This is where the mathematical concepts are embedded. In order to add up the weekly fantasy points and know the position of their team, students have to use the data from the sport statistics in mathematical equations and formulas. The students are eager to know their position, and practice the mathematical concepts in the process of knowing where they stand. There are several schools who have successfully used this and other similar strategies involving fantasy sports to teach math to students [92].

Fantasy games have also entered the realm of law. The Harlan Law Institute is home to FantasySCOTUS (http://www.fantasyscotus.net), which is a Supreme Court fantasy league for law students and high school students. For a particular case, based on the statistics and information available, students predict how each member of the United States Supreme Court will rule. Points are awarded for correct prediction [93]. The feedback has been reported to be successful, with students being enthusiastic about the game, and new players wanting to join [94].

Fantasy games have also been used in real estate so agents and buyers can be more informed of the real estate scenario. Enthusiasts have also created Fantasy Movie games (http://www.studiowars.com, http://www.fantasyfilmleague.com) where players are given a virtual budget that players can invest in movies of their liking. Depending on

how the movies perform at the box office, the players get points. There is also Fantasy Congress (http://www.fantasycongress.net/112/index.php), where people form a team of legislators by choosing both representatives and senators. Points are awarded to teams as the team-members introduce bills and try and get them passed. To play this game, the students have to learn the inner-workings and good understanding of the legislative process. Currently a website is in design for the fantasy congress, especially for teaching purposes. It will have teacher control options and more functions. It is only available to a limited audience as of June 2013.

With all the above information it is evident that fantasy sports, besides being a fun activity, has the potential to be used for educational purposes with real life consequences. With our project, we intend to exploit the use of fantasy sports to motivate people to learn more about weather patterns and climate change.

2.3 Related work

The Weather Channel (http://www.weather.com) has an Annual Fantasy Snowfall League. Figure 8 shows the logo of this league. In this league, players form teams by selecting from a list of given cities. The information about the cities, like the average snowfall for the last year, average annual snowfall, etc., is made available to the players. To play the game, the players predict cities with most snowfall in a descending order. At the end of each week, the actual snowfall is compared in the cities to the predictions by the teams based on which the teams are awarded points. The team with the highest total wins the week and gets a five-inch snowfall bonus points added to their

total snowfall score. The fantasy snowfall league had its inaugural season this year (2013). There were five teams, four from the Weather Channel TV shows and one from their own Digital Meteorologists. Each team drafted a roster of 6 cities and submitted a lineup of 4 cities they think will get the most snowfall during the upcoming week. Later it was opened to a middle school in New York State.

Figure 8. Logo of the 'Fantasy Snowfall League' by 'The Weather Channel' [95].

The snowfall league comes close to the form of gameplay that we have in mind for our fantasy weather application. But as the name suggests, this game takes only snowfall into account, and does not consider any other factors like precipitation, temperature, etc.

The American Meteorological society had a weather fantasy game (http://www.ametsoc.org/chapters/renotahoe/fantasy_wx.html). In this particular version, they took several variables like temperature, wind, snowfall, precipitation, etc. into account. But the last update to this website seems to have been done in the year 2007-

2008 (5 years ago at the time of writing of this thesis). The game seems to be finished during that period. The website displays the name of the winner and has other statistics published. But there is not much information is available lie who the game was available to, what was the objective of the game, or any other details, and there is no indication of the game currently being run. Also from the website, the game play seemed very straightforward and minimal (text and tables), with nothing very engaging or immersive.

Weathergeek (http://www.weathergeek.net/league.html) has implemented a fantasy weather concept, and takes into account multiple variables like temperature, wind and precipitation, but the user interface of the application feels dated and uninteresting. The website is not easy to navigate, and there is no signup page, or a page to see existing leagues or other information. The gameplay page where the users make predictions shows no specific layout and minimal formatting. To join the league or to get any information, there are no specific pages like signup page or a help page, and he administrator must be emailed to do so. Figure 9 shows some screenshots of this website.
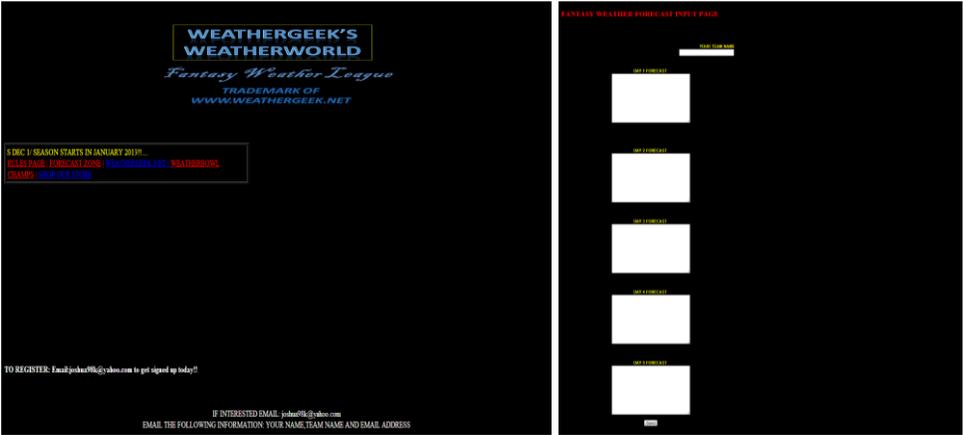

Figure 9: Screenshots from the weathergeek website (http://www.weathergeek.net).

Reality drop is another web application which tries to educate people about climate change through gamification (https://realitydrop.org). Figure 10 shows the home page of this website.
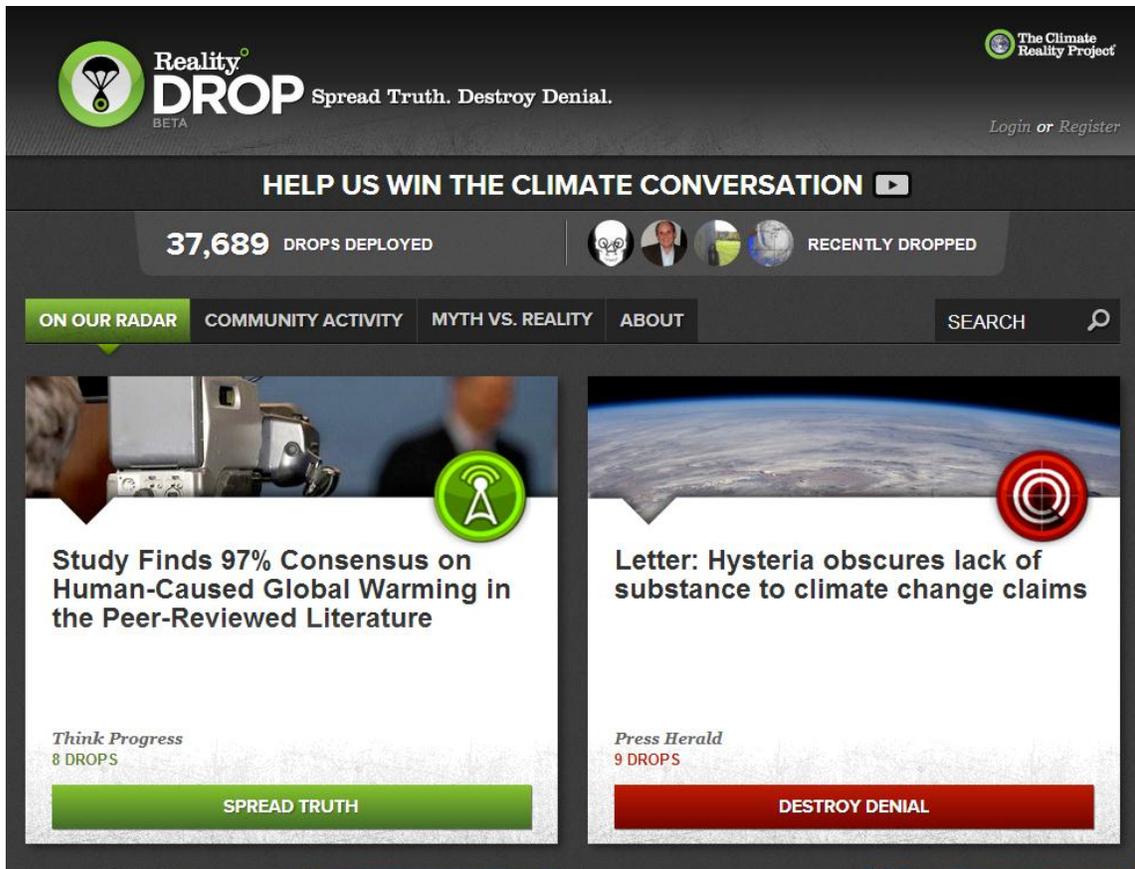
Figure 10. Reality Drop website 'gamifies' climate change to spread awareness [96].

Though Reality Drop does not use Fantasy Sports for the purpose, the application tries to serve the same objective. The application searches for heated climate change arguments over the Internet. Based on this, the users are then provided with relevant scientific climate facts. The users join the debate, and use these facts to cool down the

debate. They are awarded points for doing so, and compete amongst each other and try to obtain more points and a better rank.

CHAPTER III

FANTASY FORECASTER APPLICATION

Due to the popularity and ubiquity of Fantasy Sport games on the internet [7], we chose to the use the Internet as the platform to implement our Fantasy Forecaster application. PHP was use as the server side scripting language along with a MySQL database. In addition, common web technologies like HTML5, JavaScript and CSS were used. Using this selection has several advantages.

1. The web development tools (HTML, CSS, JavaScript, PHP) and many libraries (DOJO, jQuery, etc.) are freely available. PHP itself and these web libraries are open source and hence can be modified as desired. Furthermore, there is no need for a license or fee to develop applications for the web using the above libraries. Depending on the type of license, a commercial deployment would only require a server and a domain which can be inexpensive.

2. Websites today can support visually rich user interfaces. HTML5, CSS3 and JavaScript allow feature rich application development without the need of operating system dependent libraries.

3. One version of the application can be used across different platforms. Most platforms like Windows, Linux distributions and Mac OS have a HTML5 enabled web browser and can access the application. Though our current website is optimized for a desktop interface, most of the modern tablets and mobile browsers (iOS, Android) have a

32

good support for HTML5 and CSS3, making our application accessible on these devices.

This section describes some important features and pages of the Fantasy Forecaster application. The gameplay is explained in the next section.

3.1 Registration and login

Fantasy Forecaster provides the common standard options provided by web applications. When the user opens the application, the login screen is presented. This can be seen in the left part of Figure 11. If the user is already registered, he can login and proceed or else there is an option to register. This is shown in the right part of Figure 11. For registration, the user has to provide basic information, like the users name and email and a password. The email is necessary for communication, notifications and updates. The password is encrypted and stored in the database. Upon registration, the user is given an option to log-in.
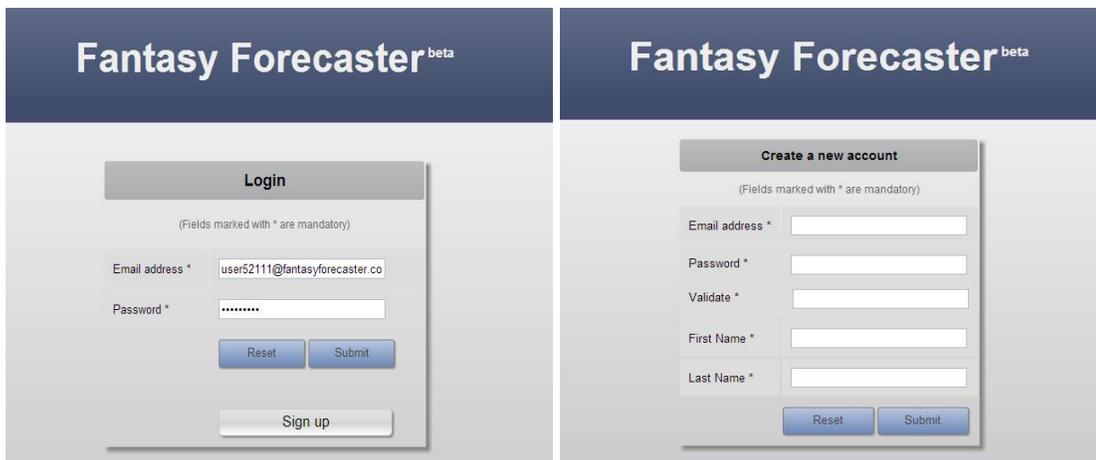

Figure 11. Login screen (left) and the registration page (right).

Once the user logs in, additional options are provided to the users on the top of the page below the log as seen in the Figure 12. The ones on the left are static which are common to all the users - turn sound on/off, 'Rules and Scoring' and 'Fun facts'. The options on the right allow users to change their profile and access other screens of the game so that the users can go back and forth between different options. The strip and the logo are visible throughout all the pages of the application.

Figure 12. The options strip is available below the logo at all times.

Once logged in, the user is presented with 'Homescreen'. The Homescreen is the 'hub' for the various features of the Fantasy Forecaster gameplay. All the game features and options are available through the Homescreen. Figure 13 shows the Homescreen.

Figure 13. The homescreen of the gameplay**.**

The user can see all the teams owned on the Homescreen. Each team name is accompanied with more information, like the league to which the team belongs, the season the team is running in, the rank of the team, the points the team has accumulated, an option to play the game, a link to see the status of the 'weather station' and an option to see the detailed performance statistics. (Depending on the status of the team, the last three options may be active or disabled).

3.2 League and team creation

At the bottom of the Homescreen, the user has to option to create a 'league' or a 'team'. In order to play the game, the user has to create a team. There are two ways to do this - one is to create a new league and a team, and another is to join an existing league. These ways are presented to the user at the top of the league and team creation page as shown in Figure 14. The explanation of different ways are as follows:

Figure 14. Team can be created in three ways.

1. Creating a new league and a team

The first option is to create a new League from scratch. This option uses the league creation wizard to create a league. The first step in the wizard requires the user to

specify the number of cities that will be the part of the league. Information like how many teams will the league include, when will the league gameplay start, how long will the league gameplay continue, if members can leave the league and if the league created will be public or private. Along with this a unique ID is generated for the league, the use of which is described in detail in the later sections. This is shown in Figure 15.

Figure 15. League creation screen.

In the next step of the wizard, the user selects the desired cities from an interactive map. The interactive map is created using the Google maps API and the cities are marked on the map using markers. When a marker is clicked, a tooltip is displayed to the user. The tooltip shows the name of the city, an interesting weather fact about the city and an option to add the city to the league. Once a city is added to the team, the marker disappears from the map. The user can see the list of cities selected below the

36

map, and has the option to remove a selected city. In this case, the city marker is re-pinned to the map. The cities thus selected will be available to the team members to select the team-member cities from. This screen is shown in Figure 16.
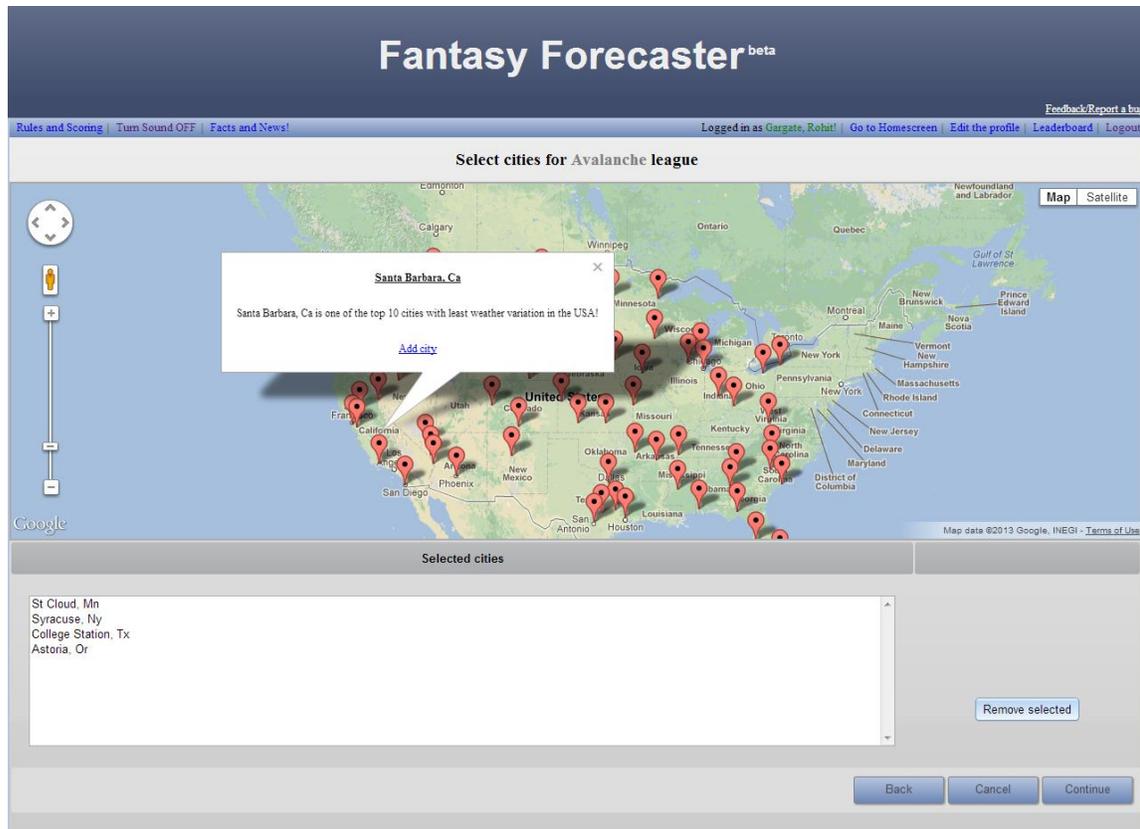

Figure 16. City selection page while creating a league.

In the next step, the user has to create a team for the league. (The user cannot create an empty league and not be a part of it.) Here the user enters the name of the team, and selects cities from the collection of cities established in the last step. The screen presented to the user is similar to that seen in Figure 16.

Once this step is done, the league and the team are successfully created, and the user is redirected to the Homescreen along with a notification that the league was created. The league creator is sent an email containing the details of the league along with the unique ID which was generated in the first step.
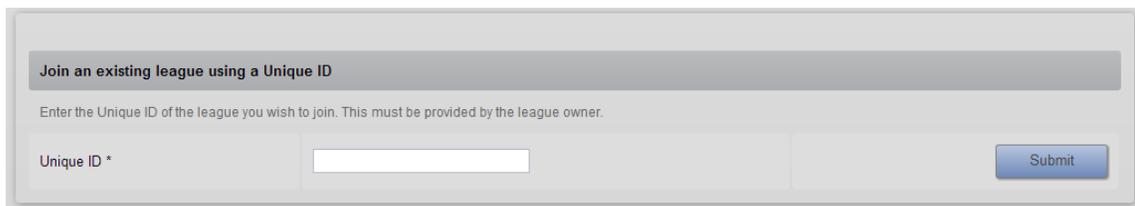
2. Join an existing league

A user can also join an existing league. The user is presented with a list of all the leagues, public and private as seen in Figure 17. The user can pick a league and proceed to joining the league by creating a new team, bounded by that league's constraints in a similar process as above. If the league is public, then the new team is directly a part of the league. If the league is private, then the league owner has to approve the user as a member. Once the user selects a league to join, the team creation process is the same as mentioned above.

Join an existing public league

League name	Creator	Public	No of Cities	Members	
Kumo	phat.cloudsx@gmail.com	no	4	1 / 4	Join
Futoy	phat.cloudsx@gmail.com	no	4	1 / 4	Join
Rage	ragingtorrentx@gmail.com	yes	4	3 / 4	Join
Private_Torrent	ragingtorrentx@gmail.com	no	4	2 / 4	Join
Fog	fatmospherus@gmail.com	no	4	1 / 4	Join
Atmosphere	fatmospherus@gmail.com	yes	4	2 / 4	Join
Howareyou	abc_121508_221824@efg.com	no	3	1 / 4	Join
willitwork	abc_121508_221824@efg.com	no	5	1 / 5	Join

Figure 17. User can choose to join from a list of existing leagues.

38

3. Join a league using a UID

One more option to join a league is using a UID. As mentioned earlier, whenever a league is created, the creator is emailed the league information along with a UID. The UID is unique for the league created. The league creator may distribute the UID amongst friends and other people, who can use it to join a league directly without having to search for that league. Once the user inputs the UID on the page as show in Figure 18, the team creation process is similar as mentioned in the first option.

Figure 18. Users can join a league using a Unique ID (UID).

3.3 The playscreen

This is the page where the user can play the game. The top part of the screen shows a map where all the cities in the player's team are marked. Below the map on the left half of the page, the cities are listed, and for each city the player can make the predictions for each of the weather variables. On the right hand side there is an empty pane. For each city, the user has the option to check the past weather statistics for that city. This information is loaded in the right half of the page. Here the user can see the average values of all the weather variables for the past 10 years, past year, past month and past week. The average values are listed and the discrete values for the time periods

are also graphically represented for each variable. This screen is explained in more detail in Section 4.1.

3.4 The achievements page

When the player starts playing a game, he owns a 'weather station'. The state or the condition of the weather station depends on the performance of the player. If the player is predicating accurately and has a good standing, the condition of the weather station stays good. On the other hand, if the player is not performing very well, then the condition of the weather station deteriorates. The idea behind the weather station is to increase the engagement of the player and encourage the player to predict more accurately.

Also on this page, the player can see his weekly and seasonal achievements in the form of medals. There is also a viewer satisfaction panel on this page, which shows how many points the player could have earned in each variable category if the predictions were better. Also here each category is designated a viewer type or an audience type which may be most interested in that category. For example Farmers would be interested in precipitation; astronomers would be interested in cloud cover, etc. This screen is explained in more detail in Section 4.2.

3.5 Facts and news page

As the name suggests, the Facts and News page shows facts on climate change and links to recent climate related news articles to the user. News links and facts are

manually pulled from the Internet and entered into the database. A fact and a news link is randomly selected and displayed to the user.

Figure 19. The 'Facts and News!' page.

A random number generator (standard PHP function) is used to do the random selection from the facts and news arrays. When the user refreshes the page, or clicks on the 'Next' link at the bottom of the page, another fact and link come up. This page is shown in Figure 19. There is a link to this page at the top left, which is visible at all times. Also, whenever any other page in the Fantasy Forecaster is loaded which is content heavy and takes some time to load, sections of this page are temporarily shown

to the user while the actual page loads in the background, so that the user can have a quick glance while waiting.

3.6 Other pages

Apart from the above mentioned pages, there are other features which are standard and common in modern websites, like password reset, profile update, etc. In addition to this, there are automated scripts which download the weather data daily into the database. The data is downloaded from the Weather Underground website (http://www.wunderground.com) in a text based comma separated format from which it is imported into the MySQL database. Another script runs on a weekly basis to calculate the player scores, update team statuses and update the database.

CHAPTER IV

FANTASY FORECASTER GAME PLAY

4.1 Playing the game

After the league creation, the league is put into 'Preseason' until the start date, which is decided by the league owner. The players in the league can play for their teams only when the league enters the 'Active season', which starts on the start date and ends after the designated duration of the league.

During the Active season, to play the game the player has to make daily predictions for temperature (minimum, mean, maximum), humidity (minimum, mean, maximum), precipitation, cloud-cover (clear, sunny, cloudy, overcast) and events (fog, rain, thunderstorm, snow, hail, tornado) for all the cities in the team through the Playscreen as shown in Figure 20. We limit ourselves to these variables so that the users are not overwhelmed. The idea is to look at the past weather statistics, understand the patterns and trends, and predict the weather as accurately as possible. In the Playscreen, when the user makes a prediction through a text input box, the background changes color or image depending on the value of the prediction. In addition, a sound event occurs, which again is based on the value of the input. Different values of temperature would give different background and sounds, and the same goes for other variables. The user has to make daily predictions for the next week. This is because the current week weather statistics are easily available through the Internet. Even if this is true for the upcoming weeks, these predictions are not very accurate. So we want the user to look at

the past and current data to make the predictions. We hope that doing this on a daily

basis for the sake of competition would trigger user's curiosity about climate change.

Figure 20. The playscreen.

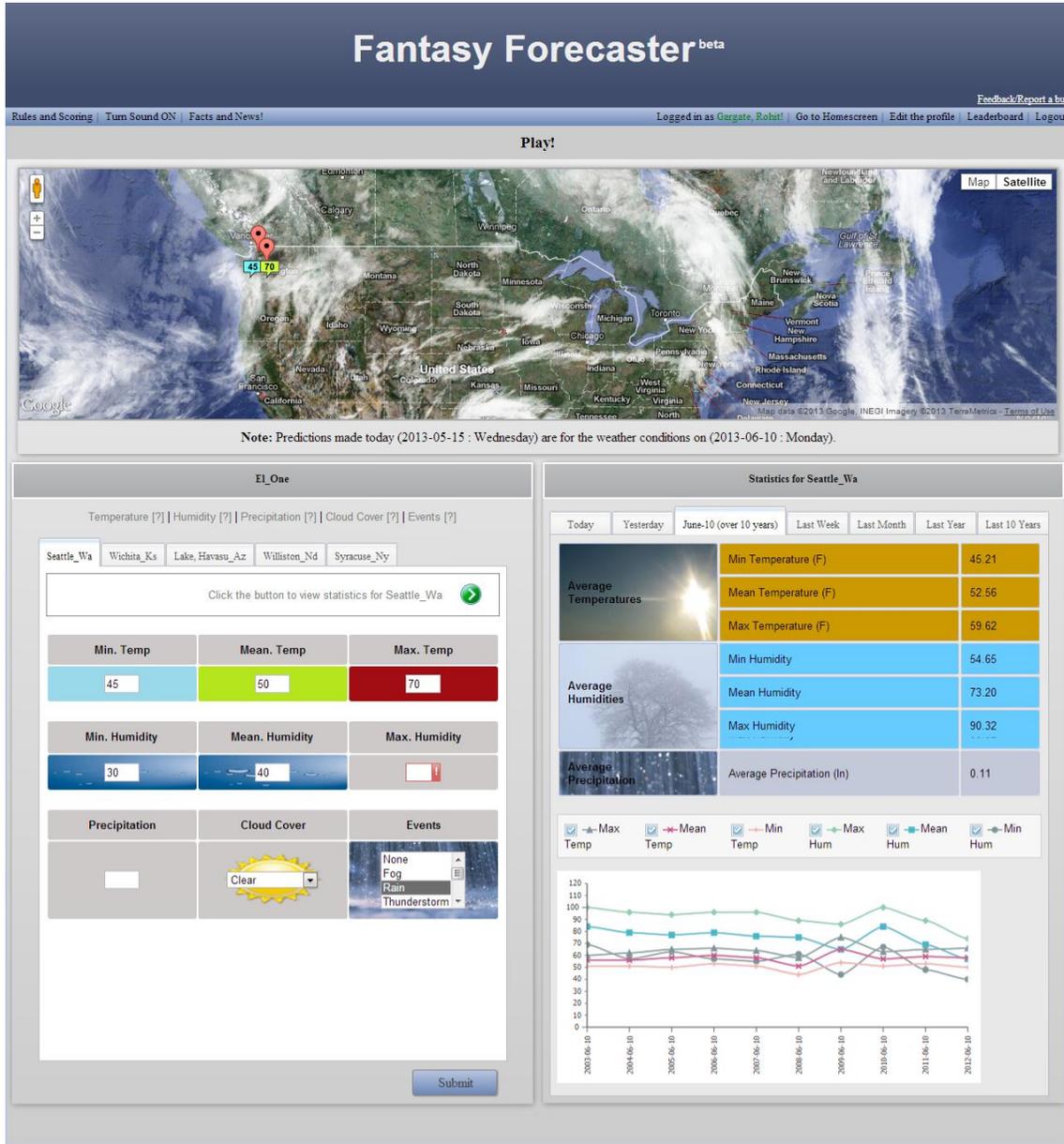Once the user has made the predictions, he can click the submit button, and the values are stored in the database. Every weekend on Sunday, an automated script uses the stored values to award points to the team. The points are awarded based on the accuracy of the predictions. More accurate predictions earn more points. Figure 21 shows the scoring scheme:

Figure 21. Page showing the scoring scheme.

After the end of the Active season, the league goes into Post season. The player cannot make the predictions anymore, and the final scoring calculations are computed and updated on the weather station page. The performance page is updated as well. The players can thus check their positions in the league in the leaderboard; check their achievements and their performance against the other members in the league.

4.2 Achievements and weather-station

As described earlier, each player has a weather station. The condition of the weather station is based on the accuracy of the predictions the player makes. The player can see the state of the weather station on the Achievements page. We try to give the user a sense of ownership which possibly increases engagement and encourages the player to play better. The Figure 22 shows the weather station.

Figure 22. The user weather station.

46

The user can also click on the help button above the image to see what the image means. Upon doing this, the user is presented with a help screen as show in Figure 23, with the condition of the player's station highlighted.
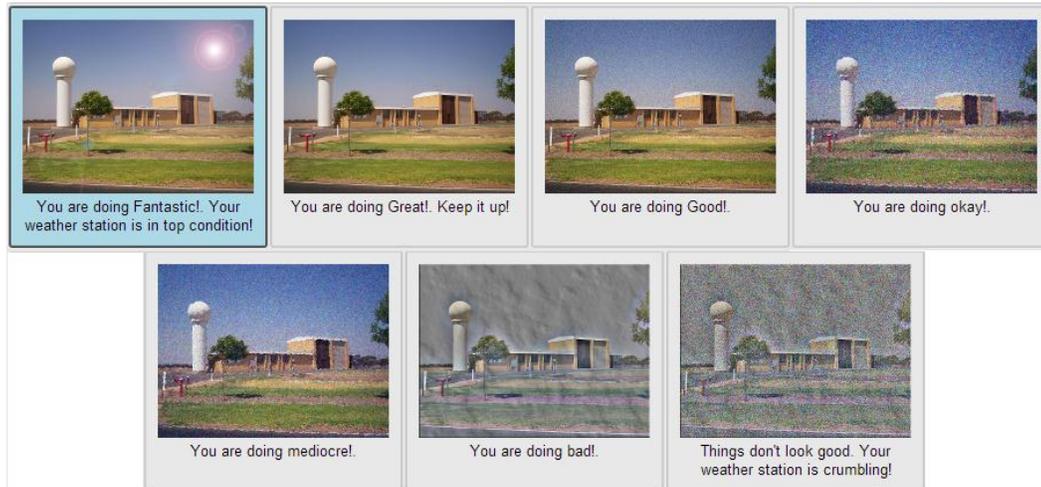
Figure 23. Different conditions of the weather station.

Every week, the top scorer in the league for each weather variable teams is assigned medal or a badge for that variable. These medals can be seen in the 'weekly medal chest' on the Weather Station page. We have included the badges to increase the consumer engagement. Badges can be seen as an encapsulation of player's interests and expertise [97]. According the Gabe Zichermann, the chair of Gamification Summit 2013 and the author of several books on gamification like: '*The Gamification Revolution (McGraw Hill, 2013)*', '*Gamification by Design (2011)*' and '*Game-Based Marketing (2010)*', "*Badges are among the most visible elements of gamification, the use of game-thinking and game mechanics to engage media audiences. A badge is one of many tools in an engagement design arsenal that also includes point systems, leaderboards,*

47

challenges, rewards, team play and achievement, among others" [98].

In addition to the badges, there is a 'weekly viewer satisfaction' next to the medal chest. Here the player can see how many points he/she could have made in case of more accurate predictions. The intention of using this is for additional player engagement besides the weekly medal chest. Just like the weekly achievements and viewer satisfaction, there are also seasonal medals and viewer satisfaction which take into account the seasonal values up to the current date. This screen can be seen in Figure 24.

4.3 Leaderboard

As explained in the earlier sections, competition is one of the motives of people who want to play fantasy sports. A 'Leaderboard' is a simple concept where players can check their standing with respect to the competition. This is similar to the commonly used point or the grade based scoring system used in education. When Google Inc. designed and launched a social networking site called Orkut, which today is widely popular in Brazil and India, they listed a simple leaderboard listing the number of people per country who had signed up. When Brazil entered the top group on that leaderboard, Brazilians began to host Orkut sign-up parties. The goal was to overtake the number one spot held by the United States. Thus, because of the success of the leaderboard feature, Orkut became Brazil's #1 social networking site [99]. Games today are increasingly using this concept for engaging existing users and attracting new users.

Figure 24. Medals (left) and viewer satisfaction (right) on the achievements page.

4.4 Player performance

Apart from the leaderboard, the players can see their standing in more statistical detail through the performance page. There is a main tab that shows the overall performance of the team and then there are tabs for each variable, where how the player performed for that variable can be seen. On each tab, there is a graph that displays the points gained by the player with respect to the time-progress of the league, against the other teams in the league. For individual variables, a comparison of the predicted variable values against the actual values for each team-city is also shown. This page is intended for the more savvy players who are interested in the minor details and statistics of the game. This screen is shown in Figure 25 and Figure 26.

Figure 25. Overall performance tab in the performance page.

Figure 26. Tab showing specific weather variable performance statistic.

Since these pages - the Performance and the Weather Station - process a lot of statistics before rendering, the user has to wait for some time until that happens. So we present the user with the 'News and Facts' page, where the user is shown random interesting climate facts and news links along with a loading animation while the user waits for the data processing to finish. This 'waiting-page' with the loading animation is shown in Figure 27. When the data is processed and the page in the background is rendered, the loading animation changes to a 'proceed' button, which the user can click to proceed to the Performance or the Weather station page. This is shown in Figure 28.

Figure 27. User sees interesting facts and news while pages load.
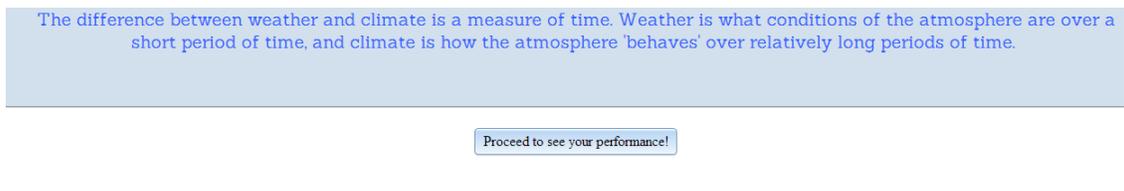
Figure 28. Bottom animation changes to a 'proceed' button once the page loads.

We change the loading animation to a button that the user has to click, and we don't directly change the page itself. This is so that the user is not interrupted if he hasn't finished reading the fact. This way the user can proceed at own convenience.

Once the season is over, the league enters the Post Season. The game is not open to be played for the teams of that league anymore and the scores are finalized. Similar to the weekly medal chest and viewer satisfaction, there is the final seasonal medal chest and viewer satisfaction.

CHAPTER V

EVALUATION AND RESULTS

5.1 Evaluation

A user study was conducted in order to evaluate the effectiveness of the Fantasy Forecaster. The idea was to gauge the user-interest, get an idea about the user friendliness of the application interface and find out if there is anything missing from the application, etc. A good evaluation of the software can be obtained from people who are not involved in the design and development of that software [100], so we invited people who were not involved or related to this project to participate in this study.

5.1.1 Participants

A total of 10 subjects participated in the user study. The participants were in the age range of 18 − 35 years, 9 male and 1 female. They were required to have basic familiarity with using a computer and browsing the web and were from diverse disciplines (Mechanical Engineering, Public Service and Administration, Electrical Engineering, Computer Science, Computer Engineering, Agriculture Engineering, Molecular Biology and Public Health). Each participant was given a randomly created identifier. This identifier was used to collect the data for the user study.

5.1.2 Application modification for survey

The fantasy forecaster has been designed so that the users have to make predictions for future dates on a daily basis. For the user study, to make this process easier so that the game could be played in one sitting, the Fantasy forecaster was modified. The user study participants were able to make predictions continuously in one sitting and get the score and performance evaluation immediately after the predictions.

In the actual application, all the teams make predictions daily and all the scores are evaluated at simultaneously. Finally the league ends and enters season after which the game cannot be played. The fantasy forecaster was modified to accommodate the fact that the participants had different dates and times of availability. Changes were made so that different participants can finish the game at their own times on different days. So even when one team was done predicting, other participants could still play the game in the same league and the performance and evaluation would be calculated appropriately including all the teams.

Thus, these modifications ensured that the user-experience would be 'complete' in just one sitting, and the participants were able to give a full feedback without having to wait for entire weeks to finish the gameplay or come back daily to make the predictions.

5.1.3 User-study protocol

Fantasy Forecaster was hosted on a server in room 232, HRBB. Since the application is still in the beta phase, it is not hosted on any public domain and had to be

accessed using an IP address with a VPN connection to the TAMU Computer Science department. For this reason, the participants were invited to come to the room to participate in the user-study. The participants were given a brief introduction about Fantasy Forecaster, after which they were asked to begin the user-study which was a 3 step process:

1. Pre-game survey: The participants were asked to answer some questions on fantasy sports and weather information before using the application. This was to get an idea of how much experience the participants have with fantasy sports, and their interest in weather and climate.

2. Gameplay: The participants were then asked to use the fantasy forecaster application. Here the participants first formed a team with the given login information, joining a pre created league, and then had to make weather predictions. The predictions had to be done for a time period of 7 days. The participants were given enough time to make the predictions and then play around with the application.

3. Post-game survey and interview: When the 2nd step was completed, the participants were asked some more questions regarding the application experience and feedback regarding the game.

5.2 Evaluation analysis and discussion

5.2.1 Pre game survey

The basic motivation behind the pre-game survey was to gauge the participants' familiarity with fantasy sports, and get an idea about their interest in climate/weather. The Figure 29 shows the statistics of the participants' with respect to the time invested in fantasy sports. The participants are labeled 1 through 10.

User Id	Years Played					Time spent per week			
	0-1 year	1-2 years	2-3 years	3-4 years	over 4 years	0-1 hour	1-2 hours	2-3 hours	3-4 hours
1									
2									
3	0-1 year								3-4 hours
4	over 4 years								3-4 hours
5	0-1 year								3-4 hours
6	0-1 year					0-1 hour			
7									
8									
9	0-1 year					0-1 hour			
10	1-2 year					0-1 hour			

Figure 29. Chart showing the familiarity of participants with fantasy sports.

Of all the 10 participants, 4 participants had never played fantasy sports. However, 2 of the 4 participants (Participant 1 and 2) were completely aware of the concept of fantasy sports and how it is played, whereas 2 participants (Particpant 7 and 8) did not know about fantasy sports, and had to be explained the concept. The players who had played fantasy sports before stated the following reasons as motivation:

Participant 3) For Challenge/Competition,

Bragging rights,

Stay in touch with friends/socialize,

Prize

Participant 4) For Challenge/Competition,

Prize

Participant 5) For the interest in the sport/keep up with sport

Gain more knowledge about the sport.

Participant 6) For the interest in the sport/keep up with sport

Gain more knowledge about the sport,

For casual pastime

Participant 9) For casual pastime.

Participant 10) For the challenge/competition

For the interest in the sport/keep up with sport

For the prize

Based on the above information, the users fall into the Casual Players and the Skilled Players categories mentioned in Section 1.3 category. This confirmed the fact that these two categories cover most of the fantasy sport player population. Also this shows that different people have different goals or reasons for why they participate in fantasy sports, confirming the achievement goal theory principle discussed earlier.

Next we asked the participants if they follow weather related news. Participants 1, 2, 5, 7 and 10 stated 'sometime', user 4, 6, 9 stated 'rarely' and participant 8 stated 'often' and user 3 stated 'never'. Upon verbal clarification, the Participants who stated 'sometime' and 'rarely' clarified that they only read weather related news if the news was significant and easily accessible, for example a thunderstorm on the front-page of a

newspaper or a website, etc. Next the participants were asked if they check weather of other cities. For these, participants 1, 2, 4, 5, 6 answered 'Yes' and the others answered 'No'. The participants who said yes to this question explained it with the following reasons:

Participant 1) To see if any significant weather events are occurring back at home.

Participant 2) My hometown weather.

Participant 4) If I'm visiting them.

Participant 5) Home.

Participant 6) Family/hometown.

Participant 10) If there is any emergency situation in some other place.

These questions make it clear that the participants only took interest in weather news when significant events occurred, and were mostly concerned about local weather and weather conditions of their hometown. This shows that people are more likely to be aware of their local weather. Only one participant was interested in general weather news.

5.2.1 Gameplay

After the pre-game questionnaire, the users were only given a brief introduction to the application. In this introduction they were told that the game play is similar to that of fantasy sports, and they have to make weather predictions for 7 days which is the duration of the league for which they will get points. They were also told that the past

weather statistics for the cities would be available inside the application. They were not shown how to go to the play screen and input the predictions, or how to find the statistics. The idea was to see whether new users can easily navigate to different pages of the application as needed and for them to explore the application.

The participants who had played fantasy sports before were easily able to navigate through the application and play the game with none or minimal help. Participants 1, 2, 7 and 8 were the ones who had not played fantasy sports before. Participants 1 and 8 had no trouble navigating through the application. Participant 2 was a little confused in the beginning and asked for confirmation if he was doing right a few times initially, after which he was fine. Participant 7 and 8 had to be shown how to form a team, then go to the Playscreen and play the game. This was not surprising given the fact that these two participants had never played fantasy sports, nor did they know about the idea behind it or how it's played.

The Table 3 shows the time taken by each participant in hours. The timer was started after the introduction, when the user logged in into the application using the given login information, and was stopped when the user had done playing, exploring the application and had logged out. Please note that the actual application requires users to make predictions daily, and here we asked the participants to do multiple days of predictions in one go. So these times do not mean much in terms of real life gameplay. But we think that these are a good indication of the user-curiosity and level of engagement of the participant.

User ID	Time Taken
1	1.15
2	2.30
3	1.00
4	1.30
5	1.15
6	0.55
7	0.50
8	1.00
9	0.40
10	1.15

Table 3. Time taken by the participants in hours.

We anticipated about 45-60 minutes per participant. This was the time we estimated to be necessary for someone to analyze past data, predict and spend some time exploring the application. As seen from the above times, all the participants spent a good amount of time playing the game, looking at weather statistics of different cities, checking out the scores and performance statistics and exploring the application. Participants 2 and 4 particularly liked the application and the concept behind it and spent more time exploring the application than actually required.

5.2.1 Post game survey and interview

This questionnaire was given to the participants after they were done using the Fantasy Forecaster. The idea was to get a feedback about the application, and get an idea about if the Fantasy Forecaster serves its purpose as an *edutainment* application.

The first two questions asked the participants that after using the Fantasy Forecaster, if they were interested to find out more about global warming/climate change and more about weather patterns in different cities. The responses to these questions are shown in Table 4:

User	Find out more about global	Find out more about weather
1	Yes	To Some Extent
2	Yes	To Some Extent
3	To Some Extent	Yes
4	Yes	Yes
5	Yes	Yes
6	To Some Extent	Yes
7	To Some Extent	To Some Extent
8	To Some Extent	Yes
9	Yes	To Some Extent
10	To Some Extent	Yes

Table 4. Participant responses to if they were interested in finding out more about climate change and weather patterns in different cities.

It was interesting that none of the participants marked 'No' as the answer to the above question. This seems to be a positive response considering the fact that studies

show decreasing public concerns over the topic [101, 102]. The study conducted in 2009 showed that the percentage of people concerned with global warming dropped from 66% to 60% in a year. Participants 1, 2 and 9 were more interested in the overall picture of climate change where as participants 3, 6, 8 and 10 thought that exploring weather patterns in different cities was interesting. Participants 4 and 5 were interested in both of these where participant 7 was minimally curious about both.

When asked if they referred to any other sources to get the weather data statistics for predictions, all the participants answered that they only used the data provided within the application, except for participant 7 who used The Weather Channel for looking up some data. The responses to the above questions indicate that though the participants were interested in finding out about weather, as indicated by the responses to the previous question, they were possibly reluctant to leave the application. This was an interesting feedback, because based on this we can embed more content inside the game in a non-intrusive fashion which then may be more used by the users of the application.

Next the participants opinion on the 'Facts and News' page was asked. As mentioned above, there was a link to this page available at all times and also this page served as a temporary screen, while some specific pages which had heavy loading in the background. The participants were asked if they noticed the weather facts and if they found it interesting. One participant (3) answered 'Did not notice', three participants (7, 8, and 10) said 'They were alright' and the rest said that 'They were interesting'. So most of the participants did notice the facts, and read through them.

Then the participants were asked if they had any comments on Facts feature. Below are the responses:

Participant 2) May be more facts as you transition between cities.

Participant 3) Yes I liked seeing it when calculations were going on (loading of performance page).

Participant 4) I liked the "Did you know" feature. I did not know any of those!

Participant 5) I like them, very interesting. The actual facts were fun.

Participant 6) Very interesting facts.

Participant 9) They were interesting.

Participant 10) More visual presentation would be interesting.

When the participants were asked comments on the News feature, 2 participants said some kind of pictures related to news would have been great, and one participant wanted more news to choose from instead of just one. Below are the responses:

Participant 4) I love the newspaper graphic! "Climate change news" is a phrase loaded with assumptions, implications and bias. There was only one link to click on. And it was random. I'd prefer multiple news links to choose different articles from.

Participant 7) Pictures (Verbal explanation: Pictures related to the news would have been interesting).

Participant 9) Yes, facts and news features were informative but I think pictures should be included.

This indicates that people may prefer graphics/media as a prelude to news articles. This prompts us to add relevant images, figures and videos alongside the news items and the facts for more user engagement.

Next, the participants were asked if they visited any of the news-links in the Fantasy Forecaster. Participants 1, 2, 4, 8 and 10 answered Yes, and participants 3, 5, 6, 7 and 9 said No. Participant 4 clarified by commenting 'But I did not really read the long articles after visiting the new page' and also verbally commented that may be small excerpts could be put below the link for a quick look. This was an interesting feedback and we will be incorporating it in the future revision of the application.

Next, the participants were asked a favorite feature of Fantasy Forecaster and another feature that they disliked. These are the responses:

Participant 1)

Liked - The availability of the past and present weather for that particular city

Disliked - The fact there were no descriptions for the x & y axis of the graphs.

Participant 2)

Liked - Badges, smiley faces! And Graph.

Disliked - Scoring was lengthy - maybe a table of contents to see specific date/city.

Participant 3)

Liked - I like the statistics presentations.

Disliked - The Google maps could have been better integrated along with the weather predictions.

Participant 4)

Liked - Seeing how my score compared to others

Disliked - I wish the average data for a city automatically loaded when I was on that cities tab entering my guesses. My least favorite thing was how much time it took waiting at times.

Participant 5)

Liked - The grading/scoring part.

Disliked - None.

Participant 6)

Liked - Interesting visual effects

Disliked - You need to click on the button to refresh statistics for each city.

Participant 7)

Liked - Prediction graphs - useful data.

Disliked - keyboard options - to change cities.

Participant 8)

Liked - Giving information for the past 10 years for each city was nice.

Disliked - Didn't have one. Looks good.

Participant 9)

Liked - The graphs

Disliked - The sounds.

Participant 10)

Liked – Predicting weather.

Disliked – Tiring – 7 day forecast at a stretch.

Overall, most participants liked the data presentation, the way the weather statistics were available in the Playscreen and the tabulation of performance statistics. In the dislikes section participant 2 disliked the way the scoring was displayed, but in the actual version of Fantasy Forecaster, this part is automatic and invisible to the users. Participant 10 thought that predicting for 7 days was tiresome, but upon verbal clarification he was again explained that in real life gameplay the predictions would be done daily, so this would not be a problem. Apart from that, most participants said that too many mouse clicks were required to show the statistics, and this should be somehow automated to change when the city is changed. This feature of automatic loading statistical data while changing cities in the Playscreen will be addressed in the future refinements to the application.

Next the participants were asked if they spend more time than normal looking at weather data and news while playing. 4 participants (2, 6, 7, and 9) answered 'No'. Participants (1, 3, 4, 5, 8, and 10) answered 'Yes'. Participants 1, 4 and 5 commented:

Participant 1) At first yes, but as I neared the end no.

Participant 4) Absolutely! Exponentially more!

Participant 5) Yes. I keep on comparing college station data with New York.

Based on the comment, participant 1 was explained again that the survey-gameplay takes longer than the actual gameplay which involves only 1 day of prediction at a time.

Next question to the participants was whether they learned anything unexpected as a result of using the application and playing the game. This was an important question in order to evaluate the Fantasy Forecaster as an edutainment application. Participants 3,

66

7, 8 and 9 answered 'No' to this question. The other participants answered 'Yes'. Below are their responses.

Participant 1) Yes, I thought that Seattle received more rain compared to New York but it is actually the reverse.

Participant 2) It Barely rains in June!

Participant 4) Many things. What average cloud cover is, variance, average rainfall.

Participant 5) I didn't realize the average temp. of Arizona (max temp) is only 89F. I expected higher.

Participant 6) learned some interesting facts. Learned about interesting measures about cloud cover units and how they are measured. Also thought Death Valley had the least rainfall in the world. However I learned that it is actually Atacama Desert.

Participant 10) learned about precipitation units.

So although 4 participants did not learn anything unexpected, the remaining participants had interesting responses, and confirm the feasibility of this application for educational purposes.

Lastly, the participants were asked overall comments about the application, where they can write about any aspect of the application. Below are the responses of the participants:

Participant 1) Labels for the x & y axis of the graph.

Participant 2) Cloud cover "Please select" needs to be formatted.

Sounds effects are well done - will kids understand Zelda and Mario sound effects?

Easy to understand interface - well done!

Last 10 years not registering.

Min Max graphs equal each other throughout tabs. Graphs were very helpful, so hopefully this can be fixed.

Maybe "Submit" or "Next city" button next to "Submit all".

Very creative and easy to understand the performance section. Appropriate for the age group.

Program did spark a curiosity in me - which set of data is most accurate? Will last year's data be irrelevant in lieu of climate change?

Could be very intuitive if done daily.

Participant 3) Min Max humidity same line in graph. Could connect the table statistics colors to graphs. Synchronize those.

Participant 4) A cool thing!

Participant 5) Would be nice to see my previous guesses from the last page.

Participant 6) Interesting to learn about the weather. Would have been more interesting if the subject was more engaging eg. sports league.

Participant 7) Instructions (How to play).

Participant 8) Rainfall indicator. E.g. When I select rainfall 0.2 inches, I didn't have an idea whether it can turn to just rain or thunderstorm etc. Adding a picture for each city (maybe a place that everyone knows).

Participant 9) Yes. I think it's a great game that could be used in elementary/high school programs to stimulate interest in climatology.

Participant 10) Min Max Mean (Verbal: The columns/rows on the Playscreen should be customizable by the user).

Fahrenheit to Celsius convertor.

Stat button should be automated.

Participants wrote about features they liked, bugs they found, missing features they thought should have been present, and other suggestions. Participant 2 who spend the most time using the application had the most comments. Overall the responses were positive and the participants seemed to like the idea of a fantasy weather game.

CHAPTER VI

CONCLUSION AND FUTURE DIRECTION

In this thesis we use the popular medium of fantasy sports to present weather data and climate facts to the users in an engaging and unconventional way through *gamification*. Using social sports to gamify data exploits the peoples need to participate in community-based activities and to enjoy and share the experience with others. Furthermore, fantasy sports have also shown to increase the player's knowledge and understanding about the domain of the sport being played. In Fantasy Forecaster, People form teams of cities, and compete against each other in leagues. To play the game, they analyze the past weather trends and predict weather for future dates. They learn about weather in this process. Also throughout the gameplay, they are exposed to interesting weather facts and news links. We intend to use this as an educational activity which will motivate people to learn about weather patterns and climatic changes.

Based on the user study evaluation, the Fantasy Forecaster seems to serve its purpose. This application can be made more user friendly by incorporating features suggested by the user study participants, like on screen instructions for new players, automatic loading of past weather data for cities while predicting, embedding facts and news feature in more places, including more graphics and media items throughout, showing multiple facts and news links from which the user can choose based on his/her interests and several other suggestions.

Fantasy Forecaster could be used as an activity in classrooms to stimulate student's interest in geography and climatology. Furthermore, by creating native applications for desktops and mobile devices, the Fantasy Forecaster can be integrated into existing weather forecasting applications, where the users will be able to play the game while checking the daily weather. Also we can integrate social media like Facebook and Twitter into the application, so that the users can share not only their achievements but also climate facts and interesting links. Similar climate change *gamification* websites like the Reality Drop can be added to get additional facts and weather debates from the Internet.

A 'Fantasy Draft' mode can be included along with the forecast mode, where the players select a group of cities and do not have to make predictions, but are awarded points based on how similar the weather is with respect to the past averages of those cities. This will be more similar to traditional fantasy sport gameplay, where the players have to update their teams depending on how the sporting event progresses. In the fantasy draft mode, the players will have to change cities based on changes expected in weather by looking at climate news and data. The objective will be the same, to try and educate people about weather patterns and climate change.

In summary, the fantasy weather game had the desired effect of causing players to explore weather data in more detail. This supports using the model of fantasy sports to motivate people to learn more about weather and climate data.

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