Enhancing Low Basketball Experience Viewer Broadcast Experience via Data Visualization: The National Basketball Association Case Study

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ABSTRACT

In recent years, sports broadcasting companies have actively embraced diverse data visualization technologies, primarily focusing on sports expertise. Taking the NBA as an example, 49% of the American population may not identify as fans, making it crucial to assess whether the general audience comprehends data visualization. This study aims to investigate the preferences and comprehension levels of low-experience NBA audiences regarding basketball broadcast interfaces and various combinations of visual elements. The goal is to enhance the viewing experience of data visualization. We requested low-experience participants to watch broadcasts from three NBA broadcasts (Bally Sports, ESPN, and TNT) and subsequently complete the Evaluation of Media Entertainment Experience, NASA-TLX, Hedonic and Utilitarian Attitudes, and Re-viewing Intention scales. Additionally, participants will be interviewed to express their opinions on the viewing experience. This study findings indicate that TNT performs the best in the Evaluation of Media Entertainment Experience, Hedonic and Utilitarian Attitudes, and Re-viewing Intention. ESPN follows as the second, and Bally Sports ranks last. Bally Sports scores the highest on the NASA-TLX scale, indicating the highest perceived workload, followed by ESPN and then TNT. Among the five visualized information, participants expressed their preferences in the following order: On-court shot clock, Lower third-player stats, Player position tracking, Shot probability, and Three-point shot distance. Despite introducing new data visualization techniques by NBA broadcasting units, the visualization of shot probability and three-point shot distance did not resonate with viewers. This suggests that there is room for optimization in the design of data visualization techniques. The study findings will serve as a reference for future basketball broadcast interface design.

Keywords: NBA broadcast interface, Data visualization, User experience, Sports

INTRODUCTION

Sports activities have always been an integral part of our lives, especially regarding the broadcast of sports events. With the development of information media, many sports events are broadcasted through various media

platforms. Numerous sports channels also integrate statistical data into their broadcast screens, aiming to provide both viewers and professional sports analysts with a deeper understanding of the game. According to the global consumer survey results (Richter, Sep 6, 2022), the National Basketball Association (NBA), abbreviated as NBA, stands out as the sporting event with the highest viewership among the young demographic. Furthermore, according to a report from MANAGER today, the total revenue of the NBA in the United States has shown an upward trend from the 2021 to the 2022 season. The combined revenue of all 30 NBA teams has recently exceeded USD 10 billion, indicating the significant importance and growth of the NBA within the sports economy in the United States.

Although there are currently many sports broadcasting platforms that emphasize improving the audience experience, the information content presented by each NBA broadcasting network varies significantly. It remains uncertain whether viewers will appreciate the information and presentation style featured on the current broadcasting interface. Study has indicated that when watching live sports events, viewers often express a desire for player information, team details, and other relevant data. Currently, they may need to access other platforms specifically for such details, indicating a challenge in meeting personalized needs (Lin et al., 2023). Furthermore, current literature on basketball data visualization predominantly focuses on sports analysts, with limited attention given to individuals with low experience. According to the study conducted by the statistical website Statista in 2023 (Statista, 2023), the non-fan audience, compared to fans, constitutes a larger demographic and generates greater economic benefits. Literature also suggests that viewers with lower experience levels tend to focus on information beyond ball handler (Jin et al., 2023).

As Augmented Reality (AR) technology matures, an increasing number of sports studies are exploring its applications. According to the literature (Goebert et al., 2022), there is a growing trend of Television (TV) integrating AR as Augmented Reality Television (ARTV).This technology is being adopted not only in sports events but also in various television programs. The following analysis will delve into recent literature on Augmented Reality (AR) and traditional information presentation. In the context of visualizing Augmented Reality (AR) in rugby, a relevant case study explored the use of situational visualization to enhance the live sports viewing experience (Lo et al., 2022), aiming to improve user engagement and experience. The study utilized Augmented Reality (AR) technology to enhance the viewers' watching experience. The authors incorporated data visualizations into the smartphone screen using AR technology. This study findings indicated that live information graphics received positive feedback compared to scenarios without charts or using traditional informational graphics. Furthermore, it was observed that the comprehension of the game was enhanced without increasing cognitive burden. In the field of basketball data visualization study, experts have explored existing Augmented Reality (AR) basketball broadcasting screens (Goebert et al., 2022). Furthermore, in the subsequent future developments, it was emphasized that the application of AR shall take into consideration the psychological aspects of a broader sports enthusiast audience. Experts have

indicated that current study on Augmented Reality (AR) sports visualization predominantly focuses on the coach and training aspects, with minimal attention given to audience experience. (Lo et al., 2022). Therefore, this study aims to explore the perspectives of individuals with low experience levels regarding basketball game broadcasts. The goal is to comprehend users' opinions on the existing NBA broadcasting interface, particularly their preferences and comprehension levels regarding visualized information. This information can serve as a reference for future study designs.

METHODS

A total of 258 participants completed an online questionnaire distributed on various social media platforms. From this pool, 30 individuals, constituting the bottom 27%, were selected as low-experience participants for the experimental investigation. The experimental samples were drawn from the NBA and included representative broadcasting platforms: Bally Sports, ESPN, and TNT. Each broadcasting platform had 10 participants engaged in the viewing experiment, watching a 2-minute compilation video of basketball goals. The experiment consisted of four steps: (1) viewing broadcast videos. (2) Undergoing comprehension assessment quizzes. (3) completing the Evaluation of Media Entertainment Experience scales (7-point Likert scale) (Rogers, 2019), NASA-TLX scale (0-10) (Dhaini et al., 2022; Mouzé-Amady et al., 2013), Hedonic and Utilitarian Attitudes scales (1-7) (Voss et al., 2003)and Re-viewing Intention scales (7-point Likert scale) (Lee et al., 2016), to reflect evaluations and feelings towards the broadcast interface. (4) Conducting semi-structured interviews to gain insights into participants' thoughts and suggestions regarding the broadcast interface and the visual elements. The study involves participants using 16-inch screens to view three different sports broadcasts. The entire viewing process is recorded through video, capturing the participants' viewing behaviors and interview.

Figure 1: Bally sports.

Figure 2: ESPN.

Figure 3: TNT.

RESULTS AND DISCUSSION

In Bally Sports, most participants demonstrated a solid comprehension of shot probability, achieving an impressive 80% accuracy rate. This indicates that the design of this information is easily comprehensible. Only 20% of participants mistakenly identified it as shot distance. Regarding the highest shot probability question, the correct response rate was 40%. Among the 20% who answered incorrectly, they mentioned that the frequent transformation of shot probability data led to participants not paying specific attention to the numerical values. Regarding the player position tracking, most participants could comprehend this information. However, 70% of participants answered incorrectly for the question about corresponding colors, while 30% answered correctly (with 10% of participants guessing). Subsequent interviews revealed that viewers do not actively memorize the colors corresponding to teams while watching. Therefore, this particular question yielded a higher error rate. Nevertheless, upon revisiting the viewing screen,

most participants could clearly identify the team information represented by the corresponding colors. For the lower third-player stats in Bally Sports, the correct response rate was only 10%, and those who answered correctly did so by guessing. Fifty percent of participants indicated that the information was presented too quickly, preventing them from capturing detailed information.

In ESPN, 50% of participants correctly identified the meaning of the three-point shot distance. Among the 50% who answered incorrectly, 20% did not specifically pay attention to this information. The remaining participants mistakenly thought it represented the shooting release position, seconds, or the distance to the three-point line. Regarding the question about the farthest three-point shot made during the entire game, the correct response rate was only 40%. Twenty percent of participants mentioned that the information displayed too many numbers and kept changing. The correct response rate for the lower third-player stats in ESPN was 0%. Among the participants who answered incorrectly, 50% mentioned that the information was displayed too quickly. Additionally, 10% of them expressed that the lower third-player stats shall not be co-located with the scoreboard.

In TNT, 70% of participants could identify the location of the on-court shot clock. Among those who answered incorrectly, participants mentioned that the display method was not prominent enough and blended too seamlessly with the floor, causing them not to notice it. Regarding the color-related question, 90% of participants correctly identified the information about the color change after the remaining 5 seconds. It was inferred as a guess among the 20% who answered correctly since they did not successfully indicate the on-court shot clock's position in the previous question. For the lower third-player stats in TNT, there was only a 20% correct response rate (guessed). All participants indicated that they did not see this information, with 10% mentioning that the color of this information was too similar to the scoreboard.

Table 1. Correctness of comprehension questions.

	Comprehension Questions	Accuracy
Bally Sports	Shot probability: What does the information above the player's head represent?	80%
	Shot probability: What is the highest shot probability in this game?	40%
	Player position tracking: What does the icon in the top right corner represent?	90%
	Player position tracking: In the graphic, what do the respective colors correspond to for the dots?	30%
	Lower third-player stats: How many points does jersey player 0 have?	10%
ESPN	Three-point shot distance: What does the information near the player's feet represent?	50%
	Three-point shot distance: What is the farthest shooting distance in feet?	40%
	Lower third-player stats: How many points does the player with jersey number 2 have?	0%
TNT	On-court shot clock: Please draw the location of the countdown timer on paper.	70%
	On-court shot clock: What color does the shot clock turn when there are 5 seconds left?	90%
	Lower third-player stats: How many points does jersey number 2 have?	20%

Based on the data results from the scales, a comparison among the three sports broadcasting platforms was conducted. The TNT demonstrated the highest performance on the Evaluation of Media Entertainment Experience scale, Hedonic and Utilitarian Attitudes scale, and Re-viewing Intention scale, followed by the ESPN, and lastly is the Bally Sports. According to the results of the NASA-TLX scale, the Bally Sports scored the highest in terms of workload, followed by ESPN, and lastly is TNT. The three experimental samples exhibited no significant differences across the four different scales.

Table 2. Three broadcasters, scale score.

	Bally Sports M(SD)	ESPN M(SD)	TNT M(SD)	F value	p value
Evaluation of Media Entertainment Experience	2.90(1.22)	3.68(0.48)	3.88(1.04)	2.059	.161
NASA-TLX	4.81(2.05)	4.73(1.03)	4.38(2.16)	0.123	.885
Hedonic and Utilitarian Attitudes	3.71(1.15)	4.40(0.55)	4.49(0.73)	2.494	.101
Re-viewing Intention	3.96(1.28)	4.13(0.61)	4.23(1.25)	.093	.911

* $p < .05$. ** $p < .01$. *** $p < .001$.

Preferences Ranking of Three Broadcast Platform

Participants ranked their preference for the three broadcast interface. The ranking of broadcast interfaces from highest to lowest is as follows: ESPN, Bally Sports, and TNT. Most participants ranked ESPN as their top choice, and many indicated that the scoreboard was one of the primary criteria for their preference. The simplicity and appropriate size of the scoreboard in this sample make it clear for participants to comprehend the current team scores. Bally Sports is ranked second, with participants expressing a preference for diverse visualized information. They particularly favored shot probability and highlighted that animated effects were among the reasons for their preference. TNT is ranked last. Most participants found that while this interface is the most minimalist, it tends to be too monotonous, especially the scoreboard. The overall presentation of information is considered too limited, making it more suitable for professional viewers. Therefore, this sample received relatively lower preference.

Comprehension Ranking of Three Broadcast Platform

Participants ranked their comprehension levels of the three broadcasters. The ranking from highest to lowest understanding of the broadcast interfaces is as follows: TNT, ESPN, and Bally Sports. Most participants who chose TNT expressed that they found its interface style to be the most straightforward. The scoreboard contains minimal information, and the visualized information is limited to the on-court shot clock, making it the easiest to comprehend. In the second position, ESPN's scoreboard in this sample is easily comprehensible, but the three-point shot distance proves excessively challenging to grasp. Ranked last is Bally Sports. In this sample, the overall information is

more abundant, and the visualized information is relatively challenging to comprehend. The advertising information on the scoreboard is particularly difficult to understand, leading to its placement at the bottom of the ranking.

Ranking of Visualized Information Preferences

Participants were asked to rank their preferences of visualized information: shot probability, three-point shot distance, player position tracking, on-court shot clock, and lower third-player stats. The results indicate that the ranking of visualized information from highest to lowest is as follows: (1) on-court shot clock, (2) lower third-player stats, (3) player position tracking, (4) shot probability, and (5) three-point shot distance. 53.3% of the participants indicated that on-court shot clock is considered crucial information in basketball games. Through this information, they can comprehend how much time remains for the offensive team to make a play. 63.3% of the participants expressed a desire to access the lower third-player stats, attributing the belief that this information enhanced their understanding of the players' scoring performance on the court. Additionally, participants indicated that they would specifically focus on the information of their favorite celebrity player if featured. Regarding player position tracking, 63.3% of participants indicated that this information allows for a better understanding of the tactical positions of players. A few individuals indicated that this information is more suitable for professional viewers, aiding in statistical analysis. Ranked second to last is the shot probability, with 56.6% of participants expressing that this information is not important, stating that displaying the shot probability does not hold significance when the key focus shall be whether the shot is successful or not. Ranked last is the three-point shot distance, with 46.6% of participants expressing a disinterest in this information. They argue that knowing the shot distance of players is unnecessary for watching basketball games.

Ranking of Visualized Information Comprehension

Because the lower third-player stats has one version for each of the three broadcast interface, and the other four visualized information each have only one version. In order to avoid the impact of different lower third-player stats on the comprehension ranking, they are not included in the comprehension ranking together with other information. The participants ranked their comprehension levels of visualized information: shot probability, three-point shot distance, player position tracking, and on-court shot clock. The results reveal that the information is ranked from easiest to comprehend to most challenging as follows: (1) player position tracking, (2) on-court shot clock, (3) three-point shot distance, and (4) shot probability. 86.6% of participants found that player position tracking were the easiest to comprehend. The use of corresponding colors for each team allowed for a clear understanding of the players' real-time positions and team tactics. The on-court shot clock was also widely understood, with a majority of participants expressing that the on-court shot clock was easily grasped at a glance, providing a clear indication of the 24-second shot clock. However, 50% of participants

noted that the display position of the on-court shot clock was not promi-nent and could be easily overlooked. The three-point shot distance ranked as the second most challenging information to comprehend. 73.3% of partici-pants found it difficult to comprehend, primarily because most of them were beginners and did not grasp the meaning of "FT." In addition to this, a few participants misinterpreted the information, perceiving it as shot probability instead. Regarding shot probability, more than half of the participants could not comprehend this information. 30% of participants did not comprehend why this information kept changing data and expressed that understanding the meaning behind the numerical values was necessary for comprehending this information. Regarding the lower third-player stats, overall, 66.6% of the participants indicated that they found it challenging to comprehend. They do not comprehend the text abbreviations within the player stats. Overall, 83.3% of the participants did not see the lower third-player stats, indicating that they found the information display too rapid. The lower third-player stats and scoreboard overlap in the ESPN and TNT samples, making them easily overlooked.

Preferences for Data Content and Type

56.6% of the participants expressed a desire to be informed about the team scores. They considered this information to be fundamental in the context of basketball games, emphasizing its necessity for presentation on the broadcast screen.56.6% of the participants wanted to access additional player-related information, including historical data, details about star players, and foul statistics. As most participants are beginners, they expressed the expectation that such information would help them better comprehend the players' situa-tions on the court. A minority of participants contends that the presentation of game time and team information is deemed essential on the broadcast interface.

Personalization Preferences

Regarding the personalized selection feature, 93.3% of the participants considered having such functionalities extremely beneficial. They support introducing this feature as it allows them to choose the information they want displayed on the broadcast screen, enhancing comprehension.

CONCLUSION

Based on the consolidation and analysis, we can summarize the perspectives and thoughts of low-experience individuals regarding the existing basketball. Broadcast interface and visualized information as follows:

The Importance of Basketball Knowledge and Information Presentation Methods on the Comprehension of Sports Events

Currently, the information provided by the three NBA broadcast interfaces seems more suitable for fans and viewers with a certain level of basketball knowledge. During the experiment, many participants found it challenging

to comprehend basketball information primarily due to insufficient knowledge, especially the lower third-player stats and the three-point shot distance. For example, 66.6% of the respondents said that the lower third-player stats were challenging to comprehend, especially the abbreviations and 23.3% suggested that player photos could be placed on the information board. In the case of three-point shot distance, participants did not comprehend the meaning of "FT." Shot probability, participants may not comprehend the meaning of percentage displays, and an unclear presentation format can also affect comprehension, leading to potential misunderstandings. In the comprehension ranking, neither three-point shot distance nor did shot probability score high positions. Conversely, regarding the on-court shot clock and player position tracking, the information design was simple and easy to comprehend. As a result, participants could quickly comprehend the information. Concerning the scoreboard, 30% of the participants find it difficult to comprehend the small text below the ESPN scoreboard. 26.6% of the participants feel that the advertising information on the right side of the Bally Sports scoreboard is very distracting. This also increases their viewing burden. On the contrary, simplifying the presentation to include only basic information such as score, time, and team names reduces their viewing burden. Therefore, simplifying information can help low-experience viewers immerse themselves more effectively in the game's atmosphere.

An Excess of Information Elements and Excessively Brief Presentation Time Can Impact the Viewing Experience

Based on this study results, it can be inferred that an excess of information elements and a presentation time that is too short affect the viewing experience. This conclusion aligns with previous study findings (Zheng & Chen, 2022). This study results show that the NASA-TLX scores for Bally Sports are the highest, indicating the highest perceived workload. The excessive information on Bally Sports' interface causes stress for low-experience viewers, 33.3% of the participants mentioning the cluttered information on this interface. Furthermore, the presentation time is crucial; information transitioning too quickly may cause participants to overlook it, leading to a lack of understanding of the conveyed message. From the comprehension assessment, it can be inferred that the lower third-player stats on the three broadcast interfaces have a display time that is too short, resulting in unread information and, consequently, a low accuracy rate.

Participants' Preference for Personalized Features

Based on the interview results, it can be concluded that 93.3% of low-experience individuals express the expectation of having personalized choices, allowing them the freedom to select the information they want to view. This conclusion aligns with previous study findings (Lin et al., 2023). Apart from basic information, each participant has unique preferences regarding the data they want to see. Therefore, personalized features are crucial in basketball game broadcasts to cater to individual viewer preferences. How to effectively present pertinent information through data

visualization is a crucial aspect. Optimizing the basketball broadcasting interface for the future involves ensuring that individuals with lower experience can easily comprehend the broadcast, attracting a greater audience of low-experienced viewers to basketball events. The future broadcasting interface are recommended to prioritize personalized functions and more intuitive information displays to expand the viewership of basketball events. According to interview feedback, 56.6% of the participants wanted to learn more about players' information and team scores during the broadcast. Therefore, it can be inferred that approximately half of the low-experience viewers express a desire to comprehend basic basketball information. They expressed that, when watching basketball games, excessive presentation of information would have a counterproductive effect. They prefer to focus on fundamental information. Furthermore, from the ranking results of preferences and comprehension, it is evident that three-point shot distance and shot probability did not capture the participants' favor. The understanding of these two pieces of information was also relatively low. It can be inferred that there is ample room for improvement in these two aspects of information.

Subsequent experiments will retain fundamental basketball information, including shot probability and three-point shot distance. Despite participants generally did not prefer these two pieces of information and were also challenged to comprehend them. These information enhance the audience's understanding of the game and meet the demands of high-experienced viewers. Therefore, future experiments will optimize these metrics to create a more engaging viewing experience.

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