Narrative's Impact on Quality of Experience in Digital Storytelling

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Abstract

Our ways of telling stories have evolved along with advances in technology. This has led to the emergence of digital storytelling. This project explores narrative influences on Quality of Experience of users in digital stories. This is done by creating and implementing a location driven digital story presented to the user by an augmented reality application on a mobile device. This narrative system has been evaluated by 30 people who have participated in a subjective evaluation. The results show that the narrative setup results in a richer, livelier and more engaging experience.

<1> Introduction

Storytelling has been a part of human culture through all human history. With technological advances, new ways of telling stories have emerged such as digital storytelling. These forms emphasize multimodality and interactivity [1] [2]. Technological developments have also led to the emergence of locative media, which use live location to determine received content [3] [4]. The use of augmented reality (AR) at historic sites is an example [5]. A popular location-based application is the mobile game Pokémon Go, which lets people find and collect virtual creatures [6] [7].

This project looks at the narrative's role in all such digital stories. The project is a collaboration with iTrollheimen, a tourism company offering tours in the Trollheimen region in Norway. They regenerate old troll folklore for their customers. A digital story based on stories from iTrollheimen will be made and implemented. An experiment involving two different setups will

be conducted on a group of people, with the goal of doing a formal, subjective evaluation of the system.

The following research question was formulated:

RQ1: Does the story affect the user's Quality of Experience (QoE) in digital storytelling?

In an interactive digital storytelling, it could be possible that the narrative no or a little role. This project will investigate whether the narrative has an impact. The following hypothesis will be tested:

The story affects the user's QoE in digital storytelling.

<2> Background

<2.1> Digital storytelling

Digital storytelling is a way of telling stories by using digital tools. As our devices have gotten smaller, the number of possibilities for these stories has increased. The story can unfold within a space and is often non-linear. Rather than being a passive observer, the participant is given an active role, and may become a part of the story.

<2.2> Locative media

In locative media, the content you get depends on your location. A location may but get meaning in the context of a story, or it may have an interactive function. It is necessary to detect a person's position, which can be done with GPS. Implementing a location-based project indoors requires an alternative to GPS [8].

<2.3> Sensor based storytelling

Sensor-based storytelling uses sensor data to tell narratives [9]. Data can be collected as a result of an interaction that the participant is conscious of, or without the participant being aware of it. An example can be that a person moves into a predefined area which triggers an event. Digital narratives can use sensor data to increase the participant's feeling of immersion.

<2.4> Case study: Rediscovering Daereungwon

An example of a location-based AR application is *Rediscovering Daereungwon* [10]. It is based on a cultural heritage site in Korea called Daereungwon. The site consists of old royal tombs. By using the application, the visitor becomes a scavenger who trespasses the forbidden burial grounds of the Silla royalty. While following the route, augmented content appears in the form of objects and people.

<2.5> Quality of Experience

The Qualinet White Paper gives the following definition of QoE [11]:

Quality of Experience (QoE) is the degree of delight or annoyance of the user of an application or service. It results from the fulfillment of his or her expectations with respect to the utility and / or enjoyment of the application or service in the light of the user's personality and current state.

<3> Methodology

<3.1> Experiment procedure and setups

Two experiments would be set up. One narrative driven, and one instruction driven. 30 participants would participate, split into 10 people in three groups. Group-1 would be tested using the narrative setup, Group-2 would test the instruction setup, while the participants of Group-3 would test both setups. The participants from Group-3 would test both setups on separate days. Each session would last 30 minutes.

Demographics: Chart 1 shows the gender distribution of the participants, while the age composition is given by Chart 2.

Procedure: After a participant enters the room, he or she would read an introduction and fill out a consent form and a demographic questionnaire, before starting the story. After finishing, the participant would fill out the survey and receive a cinema voucher. The narrative setup has an overarching narrative. In each area, the story contains a link to the next area. In the instruction

experiment the overarching narrative is removed. Each area is labeled with a numbered sheet to tell the participant where to go.

Below is a presentation of the implemented system, the story and the different interaction modalities utilized in the experiment.

<3.2> System overview

Figure 1 gives an overview of the system:

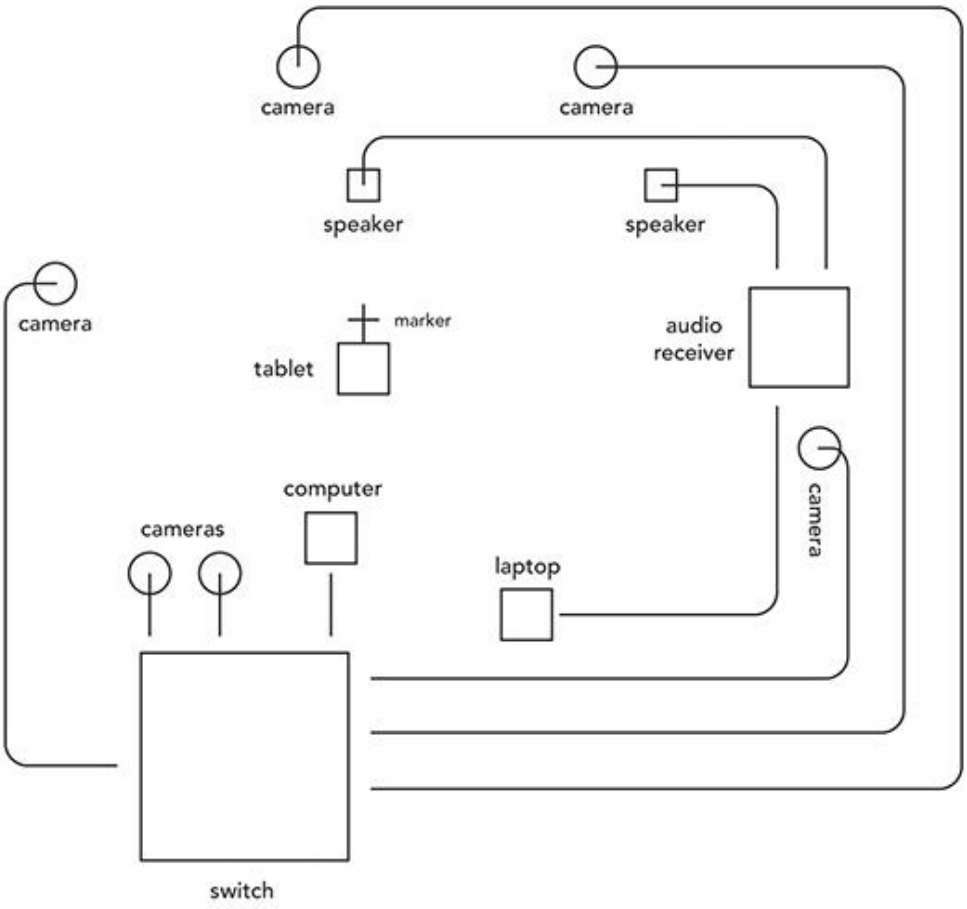

Figure 1. Overview of the system (© Øyvind Sørdal Klungre.)

An AR application made in Unity runs on a Surface Go tablet. A marker is attached to the tablet, and this marker is tracked by six cameras which constitute the OptiTrack system. The cameras are connected to a switch that is connected to a stationary computer. The computer captures

recorded data from the cameras with the Motive software. The tracking data is live streamed to a laptop which runs the Unity editor. The laptop is connected to an audio receiver, which is used as an audio amplifier for two loudspeakers.

OptiTrack: A motion capture system developed by NaturalPoint. The OptiTrack cameras track surfaces covered with retroreflective materials. Retroreflective materials reflect incoming light back to its source. Infrared light is emitted from the OptiTrack camera and is reflected by the markers. The light is then detected by the camera's sensor. 2D images from several cameras are then used to compute 3D coordinates.

Motive: A software platform made by NaturalPoint that controls motion capture systems for different tracking applications. It provides interfaces for capturing and processing of 3D data. The captured data can be recorded or live streamed to other pipelines.

Unity: A popular game engine developed by Unity Technologies. It is used to create games and interactive experiences, in 2D and 3D. Unity has become popular for making virtual reality and AR applications.

Vuforia: The Vuforia Engine is a software platform for creating AR applications, developed by the computer software company PTC. Unity now integrates the Vuforia Engine. The Vuforia engine detects and tracks images by detecting features in an image and comparing these against an image target database.

Surface Go: A tablet device developed by Microsoft. The model used in this project uses Windows 10 Pro. It has a 128 GB solid-state drive storage, and the processor is an Intel Pentium Gold 4415Y.

<3.3> Story overview

The project, Home of the Trolls, tells a fictional story of the troll world in Trollheimen. It brings to life the everyday affairs of trolls who reside in this area. It explains how natural phenomena that we observe are related to the trolls. The story is comprised of five smaller stories.

Story 1, Fausk: The first story is of Fausk, who lives in the forest. All creatures in Trollheimen fear Fausk, including other trolls. He has a foul fur which releases a lot of dandruff. This causes branches and old tree pieces to to light up with a soft, green glow in the evenings.

Story 2, Boll and Bulu: The twin trolls Boll and Bulu live amongst the stones. They are always keen on making mischief. They usually help animals escape from hunters. Boll is not smart, but he is strong. Bulu is taller and slender. He comes up with the ideas, while Boll must act them out.

Story 3, The Raven Stone: This story is about the raven stone. This is a stone found in raven nests. It makes you invisible if you put it in your mouth. The trolls have known about this for centuries, and they use these stones to walk through Trollheimen unseen.

Story 4, Fold: He is the king, and one of the oldest trolls in Trollheimen. He regularly visits all valleys in Trollheimen to maintain affairs. His advisor is the northern mountain goat. Fold can talk to the rivers, and he gets to know what the river has seen through its path.

Story 5, Minill: She is the queen of Trollheimen. She is kind, and beautiful. She is responsible for the life of the marshes in Trollheimen. When she bathes, the water that trickles from her hair provides nutrients to support the flora of the marshes. She loves peat moss and grows it everywhere.

<3.4> Prototype

The goal for the prototype was to generate a trail within a defined area, as well as implementing the story. This was achieved through a subdivision of the area into five smaller areas, as seen in Figure 2.

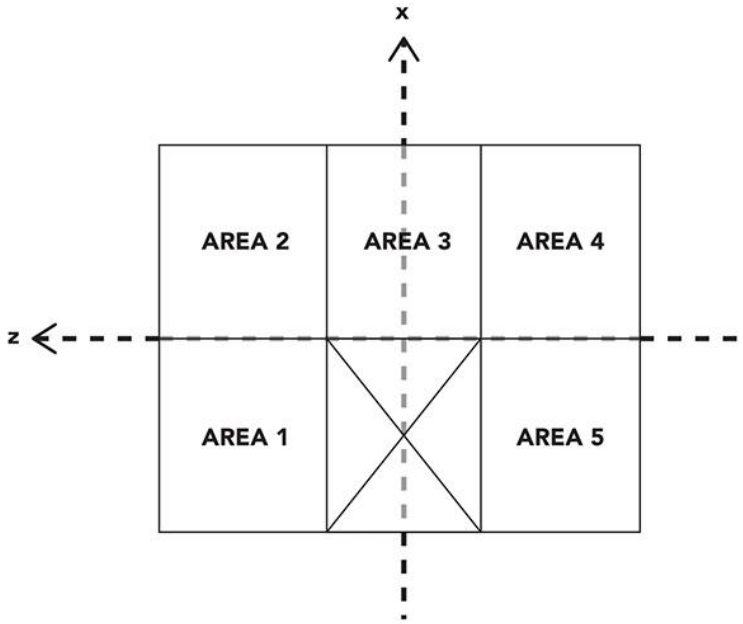

Figure 2. Division of floor area (© Øyvind Sørdal Klungre.)

The trail starts in Area 1 and ends in Area 5. Wooden plates were attached to racks, and an island was placed in the middle. The result is seen in Figure 3.

Figure 3. A picture of the prototype. The panorama picture on the wooden plate functions as a focal point in addition to playing a role in the story (Photo: Øyvind Sørdal Klungre.)

The OptiTrack system was used to play a different sound for each area, over the two loudspeakers. The tablet would play sounds caused by image detection. To detect the user position, a marker was attached to the tablet as seen in Figure 4.

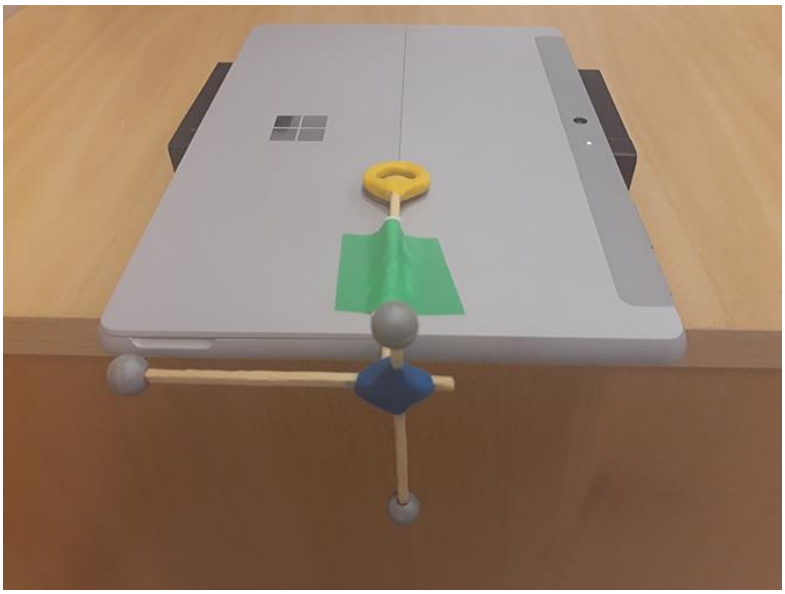

Figure 4. The tablet with markers attached (Photo: Øyvind Sørdal Klungre.)

The participant would use the tablet for interactions. It was a goal to have variation regarding the interaction and to avoid predictability. The story would also be told through texts on physical sheets.

Interaction 1, Fausk: It takes place in Area 1. Detecting pictures with the application makes 3D models of branches appear, as seen in Figure 5.

Figure 5. One of the branch models in the story. The green glow represents Fausk's dandruff (© ØYVIND SØRDAL KLUNGRE. Photo: Øyvind Sørdal Klungre.)

One of the images triggers the sound of a narrator as well. Forest sounds with bird chirps are played in this area.

Interaction 2, Boll and Bulu: This takes place in Area 2. Virtual sheets with texts appear as seen in Figure 6, as well as a handprint and a footprint. Two troll models resembling Boll and Bulu appear on the floor pictures, as Figure 7 shows. The sounds of a thunderstorm are heard here.

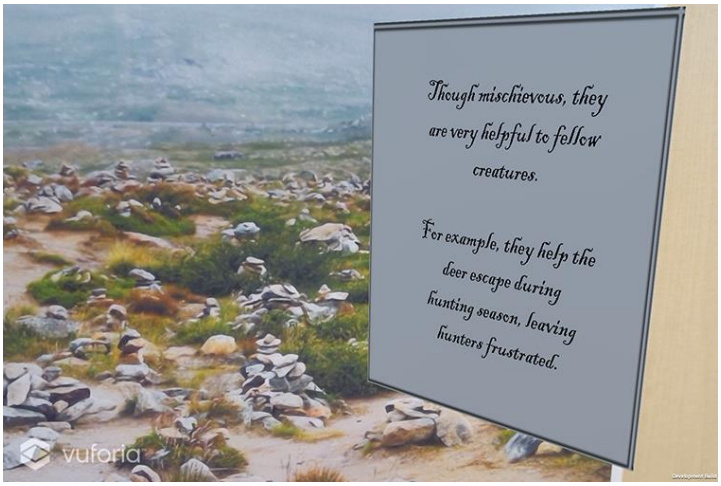

Figure 6. Texts on virtual sheets tell the story about Boll and Bulu. (Photo: Øyvind Sørdal Klungre)

Figure 7. The troll model which resembles Boll (Photo: Øyvind Sørdal Klungre.)

Interaction 3, The Raven stone: This takes place in Area 3. Instead of nature sounds, the user hears music. The nest image triggers the narrator's voice as well as making the raven stone appear.

Interaction 4, Fold: This happens in Area 4. Nature sounds in the form of bird chirps return here. An image makes the narrator start talking. Another image triggers a picture of the mountain goat, in addition to the narrator's voice.

Interaction 5, Minill: The final interaction takes place in Area 5, shown in Figure 8. Flowers, bushes and moss appear when detecting the images as seen in Figure 9. This happens while river sounds are heard from the loudspeakers.

Figure 8. View of prototype area (Photo: Øyvind Sørdal Klungre.)

Figure 9. The participant finds Minill's moss in the last area (Photo: Øyvind Sørdal Klungre.)

<4> Formal experiments

A 25-item questionnaire was made. The survey was synthesized from the following standardized questionnaires: the Temple Presence Inventory (TPI) questionnaire [12], Core Elements of the Gaming Experience Questionnaire (CEGEQ) [13], and Game Experience Questionnaire [14]. The questions were adjusted to fit the experiment. Each question was answered with a 7-point Likert scale. Most questions were formulated so that the answers were from 1 (negative response) to 7 (positive response).

The results were analyzed by comparing the Mean Opinion Score (MOS) of each question. This was done with the t-distribution, which is based on normally distributed data along a continuous scale. Here, a discrete seven-step scale is used, so the assumptions for the t-distribution might not be fulfilled. But it was assumed that the t-distribution could still give valid results. Unpaired t-tests were used for the responses from Group-1 and Group-2, while paired t-tests were used for Group-3. This was done while assuming normal distributions and equal variances. The results are given as MOS bar charts with error bars representing 95 percent confidence intervals.

Figure 8 shows a picture from one of the experiments.

Figure 10. A picture from one of the experiments. It was a point to let the participants explore different heights (Photo: Øyvind Sørdal Klungre.)

<5> Results

The first five questions in the survey were: **Q1.** *"Did the experience seem more like looking at the events/people on a movie screen or more like looking at the events/people through a window? (Like a movie screen - Like a window)'";* **Q2.** *"To what extent did you feel mentally immersed in the experience or distant from it? (Distant - Immersed)";* **Q3.** *"To what extent did you feel a part of the experience? (Uninvolved - Involved)";* **Q4.** *"How exciting was the experience? (Boring – Exciting)";* **Q5.** "W*as it emotionally engaging? (Unemotional - Emotional)".* The results for group 1 and group 2 are shown in Chart 3, while Chart 4 shows the results for group 3.

The next five questions were: **Q6.** "*Would you evaluate the experience as dead or lively? (Dead - Lively)";* **Q7.** *"How annoying or enjoyable was the experience? (Annoying - Enjoyable)";* **Q8.** *"Did you find the experience surprising or predictable? (Predictable - Surprising)";* **Q9.** *"Did the directions you got along the trail seem obstructive or supportive? (Obstructive - Supportive)";* **Q10.** *"Did the experience feel complicated or easy? (Complicated - Easy [7 points])".* Chart 5 shows the results for Group-1 and Group-2.. For question 6, the difference favors the narrative setup with a significance level of 0.10. The results for Group-3 are presented in Chart 6. For question 10 the difference benefits the instruction setup with a significance level of 0.05.

Questions 11 to 15 were: **Q11.** *"Was the experience motivating or demotivating? (Demotivating - Motivating)";* **Q12.** *"Did you find the experience clear or confusing? (Confusing - Clear)";* **Q13.** *"Did the trail you followed seem organized or cluttered? (Cluttered - Organized)";* **Q14.** *"Did you feel that you could explore things? (Could not explore - Could explore)";* **Q15.** *"How was the experience in essence? (Poor - Rich)".* The results for Group-1 and Group-2 are shown in Chart 7. Question 15 benefits the narrative setup with a significance level equal to 0.10. The results for Group-3 are given by Chart 8.

The next five questions were: **Q16.** *"How imaginative did you feel along the trail? (Unimaginative - Imaginative)";* **Q17.** *"Did you feel free or pressured during the experience? (Pressured - Free)";* **Q18.** *"Did you feel exhausted or relaxed after the experience? (Exhausted - Relaxed)";* **Q19.** *"What was your sense of achievement? (Meaningless - Purposeful)'";* **Q20.** *"How did you feel during the experience? (Bad - Good)".* Chart 9 gives the results for Group-1 and Group-2. The results for Group-3 are given in Chart 10.

The last questions in the survey were: **Q21.** *"How easy was it to get back to reality after the experience? (Hard - Easy)'";* **Q22.** *"How gratifying was with the experience for you? (Irritating - Satisfying";* **Q23.** *"How effected were you by the experience? (Unengaged - Engaged)";* **Q24.** *"How much did you feel like yourself in this experience? (Participant - Explorer)";* **Q25.** *"What was memorable from the experience? (Sights and Sounds - Characters)".* The results for Group-1 and Group-2 are given in Chart 11. Question 23 has a significant difference in favor of the narrative setup. The difference corresponds to a significance level of 0.10. The results for Group-3 are given in Chart 12.

<6> Summary

It was expected that the narrative experiment would give a better experience. The notable differences for questions 6, 15 and 23 for Group-1 and Group-2 are in according with this. Another expectation was that the differences would be greater for Group-3, since this group could compare the experiments. Instead, the differences were smaller. The responses from these participantes seems to reflect the overall impression of the setups. Group-3 also tended to respond more favorably to both setups than Group-2. This implies that the instruction setup in isolation was able to give more negative responses than the setups combined.

A surprising result was that the participants in Group-3 found the instruction setup to be significantly easier. This happened even if the participants did not do the setup in a fixed order. One participant who did the instruction setup first said that the narrative setup was confusing. Another participant, who did the narrative setup first, explained that the instruction setup was easier. The results indicate that the proposed hypothesis is true, that is that the narrative affects the QoE.

<7> Conclusion and further work

A subjective evaluation has been performed on an interactive digital story, to investigate the narrative's influence on the QoE. This has been done by developing an AR application in Unity, and by using the OptiTrack system to detect the user's position. An experiment was conducted on 30 test subjects divided into three groups. Group-1 was tested on the narrative setup, Group-2 on the instruction setup, and Group-3 on both setups.

The participants in Group-1 had a richer, livelier and more engaging experience than the participants in Group-2. These results were according to the hypothesis. For Group-3, the instruction setup was significantly easier than the narrative driven approach. It is concluded that the proposed hypothesis is true.

This work is now taken away from the lab setup and expanded out to an open area. Motion tracking is substituted with GPS. The prototype will be further developed for location-based adventure tourism.

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Tables and Charts

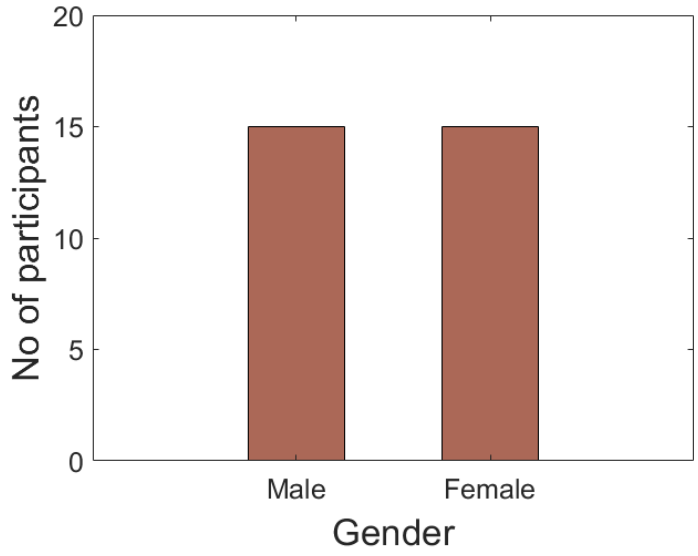


Chart 1. Gender distribution of participants.

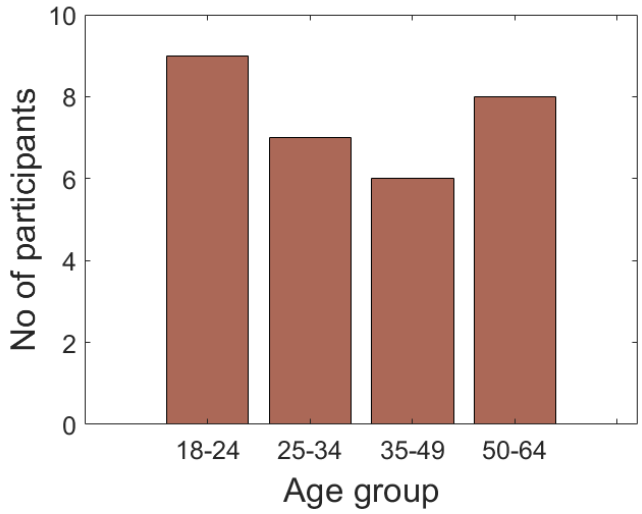


Chart 2. Age composition of participants.

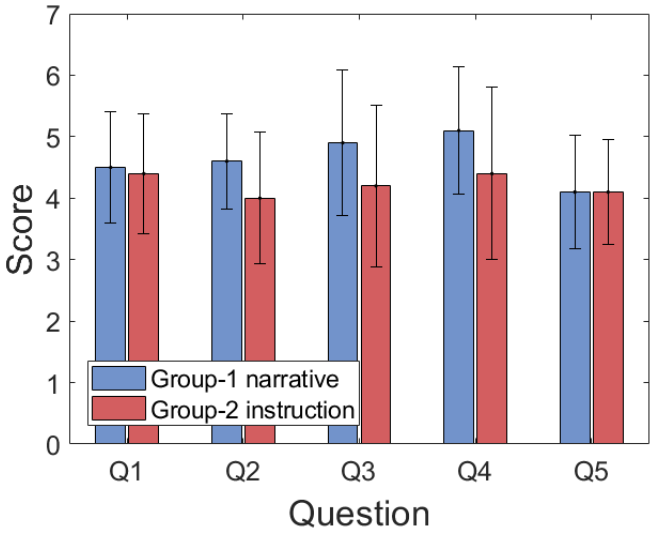
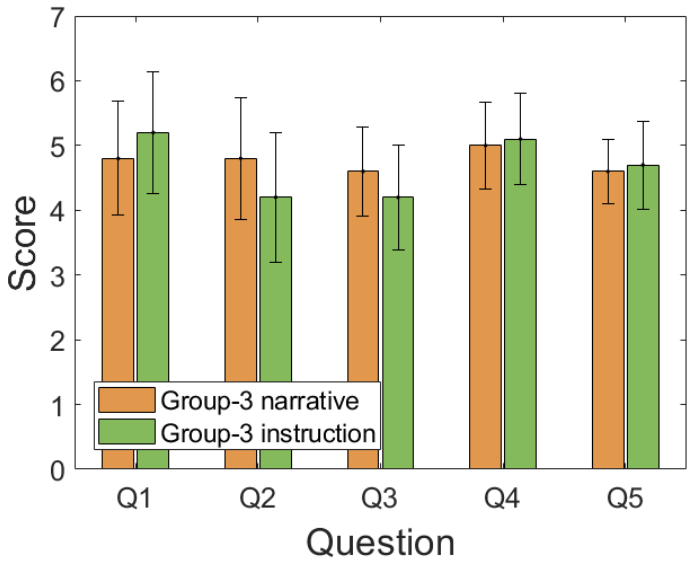


Chart 3. Average scores for questions 1 to 5 in Group-1 and Group-2.



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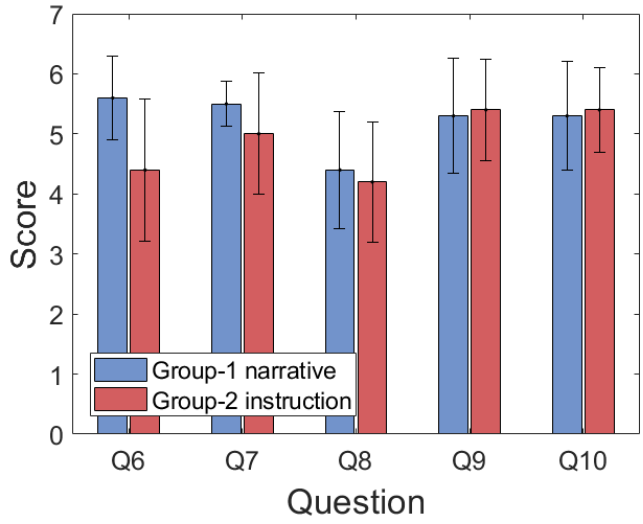


Chart 5. Average scores for questions 6 to 10 in Group-1 and Group-2..

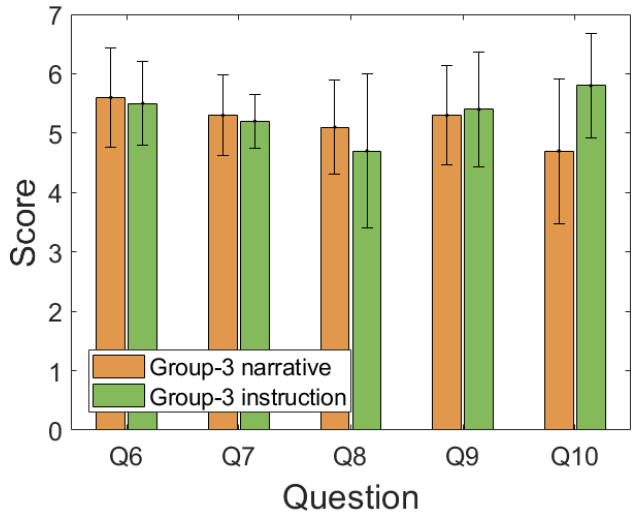


Chart 6. Average scores for questions 6 to 10 in Group-3.

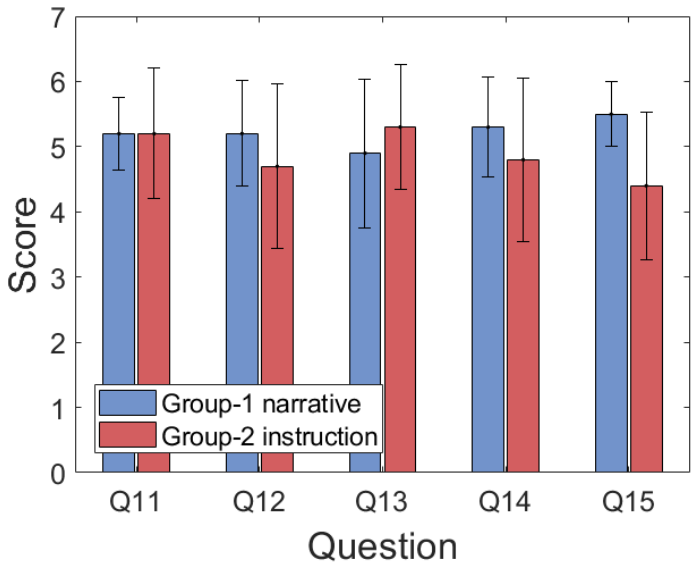
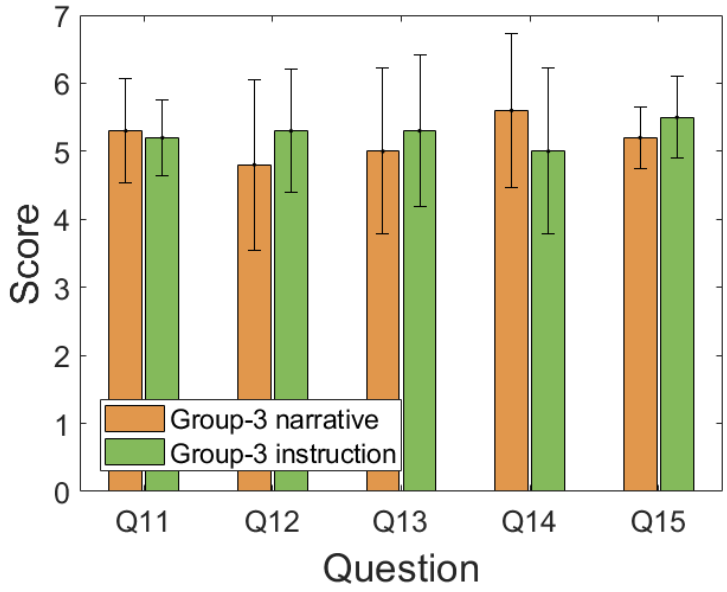


Chart 7. Average scores for questions 11 to 15 in Group-1 and Group-2..



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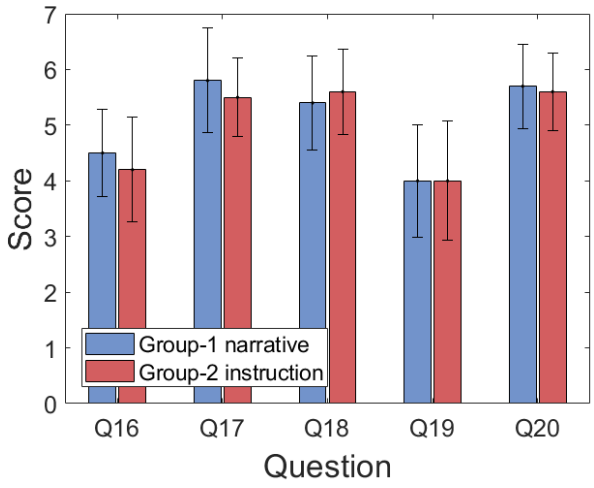

Chart 9. Average scores for questions 16 to 20 in Group-1 and Group-2..

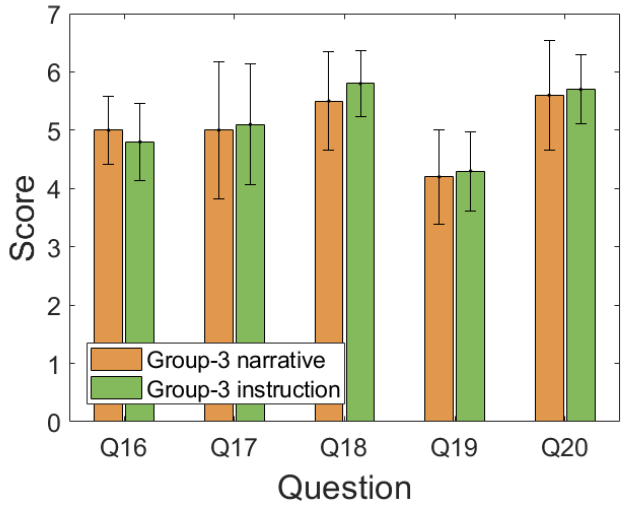

Chart 10. Average scores for questions 16 to 20 in Group-3.

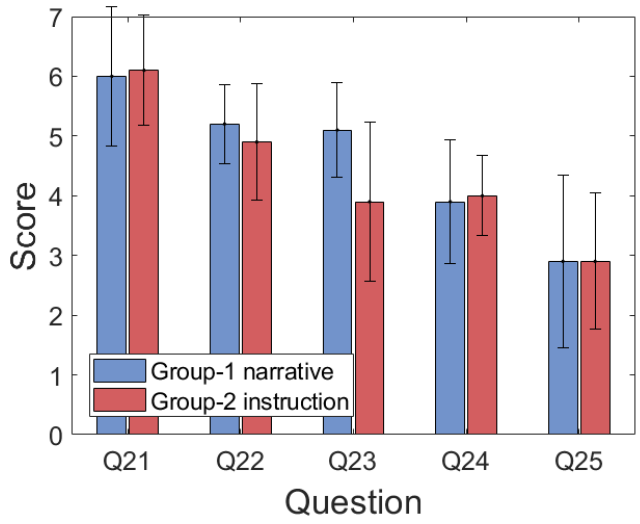

Chart 11. Average scores for questions 21 to 25 in Group-1 and Group-2.

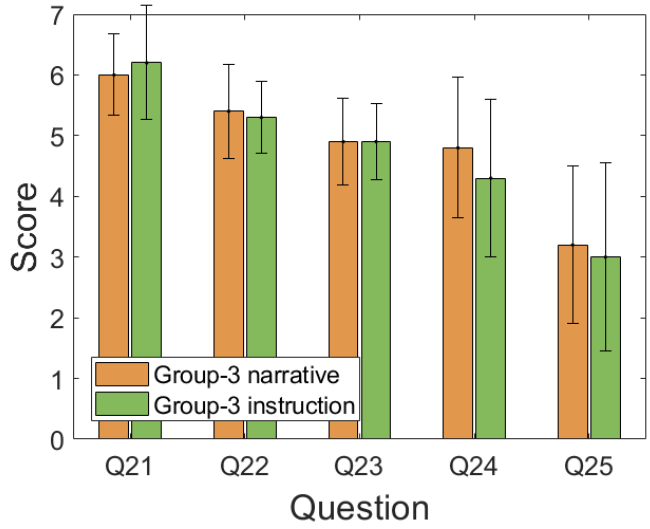

Chart 12. Average scores for questions 21 to 25 in Group-3.