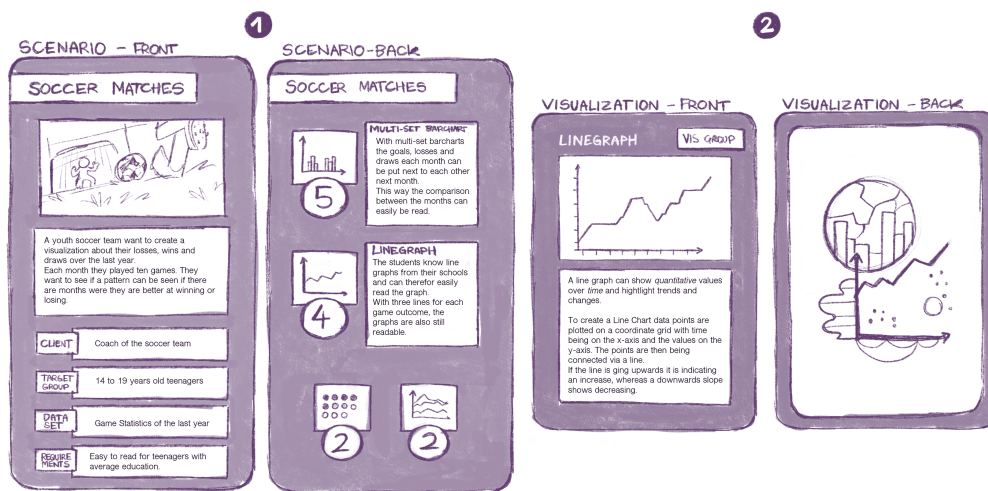


# Cards, Charts, and Strategy: A Game-Based Approach to Data Visualization for Pattern

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**Figure 1:** Example of the card designs for the game. The bigger card on the left (1) depicts a scenario of a soccer team that wants to show the outcome of their games from the last year in a visualization (on the front side). On the back side of this card, the scoring for the visualization cards can be seen. On the right side (2) is the example of a card featuring a data visualization type, including an explanation of how to read and create it.

## Abstract

In today's society, the ability to read and interpret data visualizations has become a critical skill in both professional and academic contexts. Therefore, fostering visualization literacy from an early stage is essential in teaching students to understand and interpret different types data visualizations. Research highlights gamification as an effective method for enhancing visualization literacy by promoting active learning and motivating learners of all ages. In this context, a card game has been developed to challenge players to identify the most appropriate visualization type for different given datasets. This educational card game aims to deepen understanding and practical application of data visualization concepts while maintaining an engaging and interactive experience for learners.

## CCS Concepts

• **Human-centered computing** → Visualization design and evaluation methods; • **Applied computing** → Interactive learning environments; • **Computing methodologies** → Data visualization; Game design and development;

## 1. Introduction

Research has shown that data visualization is an essential aspect of a critical and informed society, and therefore, it needs to be part of our education [BKR\*24]. To better engage students and children in

learning about data visualizations, it is essential to employ creative teaching methods [RBB\*22]. One way can be games.

Games are structured forms of play that engage participants through defined rules, objectives, competition, or collaboration.

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Games provide an environment for individuals to explore complex concepts, develop skills, and foster creativity. Across various disciplines – including mathematics, science, history, and language – games have been effectively integrated into educational settings [SJ03,May19], proving to be powerful tools for enhancing learning experiences.

There have also already been ventures in the area of card games to teach data visualization, such as VizItCards [HA17] and Vis-Futures [vis], the The Graphic Continuum: Match It Game [Mat]. Those games feature a small selection of visualization types and offer a more generic view of data visualization creation. Visualization games that guide players through concrete usage scenarios are rare.

Therefore, we introduced the card game “Vizioneire”. It confronts players with specific scenarios in which they have to find the most fitting data visualization type. The different scenarios are represented as cards, as shown in Figure 1 (1) front side. The players have to decide in teams which data visualization would be the most fitting one for that specific scenario. They do that by discussing the cards in their hand and brainstorming about which one is the best to choose. Based on a scoring system for each scenario, the visualization card that suits the scenario the best wins the round.

The game combines both cooperative and competitive elements. To keep the scope of the first prototype manageable, the game focuses specifically on data visualization types that fall under the “Patterns” category of The Data Vis Catalogue schema [Cat]. This category includes visualization types that highlight structure or meaning within datasets by revealing underlying forms or trends, such as: arc diagram, area graph, bar chart, box & whisker plot, bubble chart, candlestick chart, choropleth map, connection map, density plot, dot map, dot matrix chart, heatmap, histogram, kagi chart, line chart, multi-set bar chart, open-high-low-close chart, parallel coordinates plot, point & figure chart, population chart, radar chart, scatterplot, spiral plot, stacked area graph, stream graph, timeline, and violin plot. The selection of these visualization types ensures that players are exposed to visualization techniques that are both versatile and foundational, supporting a wide range of analytical tasks, e.g., identifying trends, comparing categories, visualizing distributions, and uncovering relationships in data. The game aims to reinforce learning through repetition and targeted practice, helping players to *remember*, *understand*, and *apply* these visualization methods [Blo56] in a fun and engaging way.

The card game is designed for undergraduate computer science students taking their first course in data visualization. It serves as a supplementary learning method to reinforce key concepts from lectures, making the material more engaging and easier to grasp for students with no prior experience.

## 2. Goals and Rules of Play

The primary objective of this game is to enhance players’ understanding of data visualizations. By engaging with various real-world scenarios, players will develop the experience and expertise necessary to select the most appropriate visualization for specific tasks and given datasets.

Each round centers around a “Scenario card”, which presents a

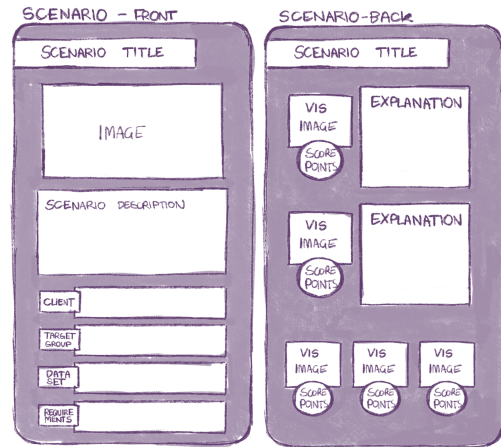


Figure 2: Layout Mockup of the front and back of a Scenario card.

specific data set, its intended use, and the target audience. Within a one-minute timeframe, team members collaboratively discuss which card from their hand best corresponds to the scenario. This phase of the game encourages critical thinking and fosters teamwork. It is crucial that during the phase, the players communicate effectively within their own team to avoid distracting or assisting the opposing team. Once the one-minute discussion phase has ended, the “Visualization card” with the highest scores wins the round. The objective of this game is to accumulate as many round scores as possible. As the game is played more frequently, it aims to enhance players’ understanding of which visualization types are most suitable for specific scenarios, which acquire skills for real-world contexts.

## 3. Short Game Manual

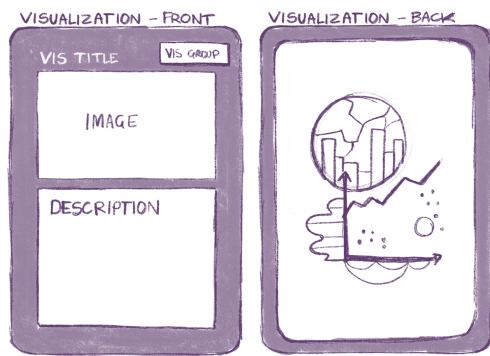
The game is played with two different card decks – Scenario cards & Visualization cards – that will be described in the following two paragraphs (see Figure 2, and Figure 3).

**Scenario Cards** feature fictional scenarios that require data visualization to represent them in a suitable way, as illustrated in Figure 2 on the front side of the card. The front of the card is structured into two main parts, one being the general information featuring a name and an image, whereas the second part provides all the needed information for the gameplay:

- Who is the target audience?
- Which data have to be visualized?
- What are the requirements for the visualization?

In the game, players must then select the most appropriate data visualization type following these factors presented on the “Scenario Card”.

The backside of the cards displays the results, including the scores for the most suitable visualization types, along with an explanation for the two best options. For additional suitable visualizations, only the score points are provided without explanations.



**Figure 3:** Layout Mockup of the front and back of a Visualization card.

If fewer than five visualizations are possible, the number of boxes containing score points is reduced accordingly.

In Figure 1, the card design of one specific scenario is illustrated. In this example, the “Scenario Card” involves a youth soccer team that wants to visualize their game outcomes – wins, losses, and draws – over the past few years, broken down by month. Since the intended audience is teenagers aged fourteen to nineteen, the chosen visualization should be easily readable by students with an average educational background (requirement). In this case, the best-suited visualizations would be a multi-set bar chart or a line graph, as both use intuitive visual mappings and are commonly encountered in the wild.

**Visualization Cards** picture the different data visualizations (illustrated in Figure 3) that reveal forms or patterns in the data to give it meaning based on the Data Vis Catalogue [Cat]. To facilitate the categorization of data visualizations, they are grouped into four categories: Comparison/Relations, Distribution, Temporal, and Geographic. Each category is assigned a specific color to enhance differentiation and improve visual clarity.

The **Comparison/Relations** group (blue) features the visualization types: Bar Chart, Multi-set Bar Chart, Scatterplot, Bubble Chart, Radar Chart, Parallel Coordinates Plot, and Arc Diagram.

In the **Distribution group** (red) cover the types: Box and Whisker Plot, Violin Plot, Density Plot, Histogram, Dot Matrix Chart, and Population Pyramid can be found.

The group **Temporal** (green) includes: Line Graph, Area Graph, Stacked Area Graph, Stream Graph, Candlestick Charts, Open-high-low-close Chart, Point and Figure Chart, Kagi Chart, Timeline and Spiral Plot.

The group **Geographic** (yellow) consists of a Connection Map, Choropleth Map, Dot Map, and Heat Map.

The layout of the Visualization cards, as shown in Figure 3, includes the title of the visualization next to a colored box representing the group, with the group name displayed inside. The card also features an image illustrating the specific visualization, accompanied by a descriptive text. This text explains the visualization’s function, along with additional relevant details.

### 3.1. Game Setup

1. Both the Scenario and the Visualization cards get shuffled. The Scenario deck gets placed in the deck box with the Description-Side face-up. The Visualization Deck is placed face-down next to the deck box.
2. If there are four or more players, the players have to separate into two teams. Otherwise, the players play together as one team against the game.
3. Each player is dealt five “Visualization cards”.
4. As a last step, the first card dealer is selected. The dealer role rotates each round of the game.

### 3.2. Gameplay

1. To start a round, the first card from the Scenario deck gets drawn by the card dealer and placed face-up on the middle of the table. It is crucial to ensure that no player sees the backside of the card during this process.
2. Every player reads the details of the “Scenario card” silently. Once everyone is ready for the next phase, the card dealer starts the timer.
3. While the timer is running, the members of each team discuss which of their “Visualization cards” is most suitable for the current scenario. They can choose any of the cards from their hands. After the team has agreed on one “Visualization card” that they want to play, they have to put that card face down on the table close to them. It is very important to place the card before the time has run out, or the card won’t be counted for the point score.
4. As soon as one minute has passed and every team has chosen their cards, all the cards lying face-down on the table get turned over, including the “Scenario card”. On the backside of the “Scenario card” is a score list written with information about which “Visualization card” gains which amount of points. Both teams calculate their achieved points. The team with the most points wins this round and gains the “Scenario card”. If a team collects their fifth “Scenario card”, the game ends, and that team is declared the winner. The next round begins if neither team has acquired their fifth “Scenario card”. Each player draws additional cards to reach their hand limit of five cards, and a new card dealer is selected from the opposite team, as in the previous round. The game then proceeds with step 1.

If there are under three players, different game play rules apply as described as follows:

1. The steps 1 to 3 remain the same. However, unlike the version with two teams, the goal for each team is to reach a specific point total within five rounds. When calculating their points after each round, the team must check if they have reached the required winning score.
2. If that is not the case, the team will choose a new card dealer from their team and proceed with the same actions of redrawing and starting a new round.
3. The game ends either when the winning score is reached or after five rounds have been completed. In the former case, the team is declared the winner; in the latter, the game is considered the winner.

#### 4. Material Overview

The card game consists of two card decks, one deckbox, and a timer. The timer can be a typical hourglass known from a broad range of board games or a digital timer on a mobile phone. The “Scenario card” deck is being kept in the deckbox to prevent players from seeing the back side of the cards in advance. The “Visualization cards” have the standard size of playing cards of 6.35 cm x 8.89 cm, whereas the “Scenario cards” have a size 6.8 cm x 12 cm to include all the information needed for the scenarios. We provide the cards in the supplementary material.

It is planned to create fifty different “Scenario Cards” to generate a wide variety. For the “Visualization cards” the correct balance of each type is still being tested. For testing purposes, each type is intended to have three to five cards.

#### 5. Planned Usage

This card game has not yet been played with students prior to the submission of this extended abstract paper. At the time of writing, the game is still being developed as part of a bachelor’s thesis. As part of this thesis, an expert interview and a focus group with students from the University of Applied Sciences St. Pölten are planned.

There are two different ways to win this game, depending on the number of players participating. When there are one to three players, they play as a single team and must reach a certain number of points within five rounds. In this version of the game, the team plays against the game itself.

The other variation is with more than three players, where all the players form two teams and compete against each other. Instead of the version with just one team, in this case, the teams need to win five “Scenario cards” to win the game. They can achieve this by scoring the most points in one round and gaining the Scenario card of that round. A more detailed explanation can be found in the Gameplay Section 3.2.

#### 6. Reflection & Conclusion

Through this game, players will gain hands-on experience in selecting the most appropriate data visualizations for various real-world scenarios, enhancing their critical thinking skills in the process. The game aims to bridge theoretical knowledge with practical application, helping players deepen their understanding of data visualization principles and their real-world relevance.

At the time of this workshop paper, the game hasn’t yet been tested with users; therefore, it is still a prototype and will very likely experience changes based on the feedback gathered from the participants of this VisGames workshop and the planned evaluations.

#### 7. Acknowledgements

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