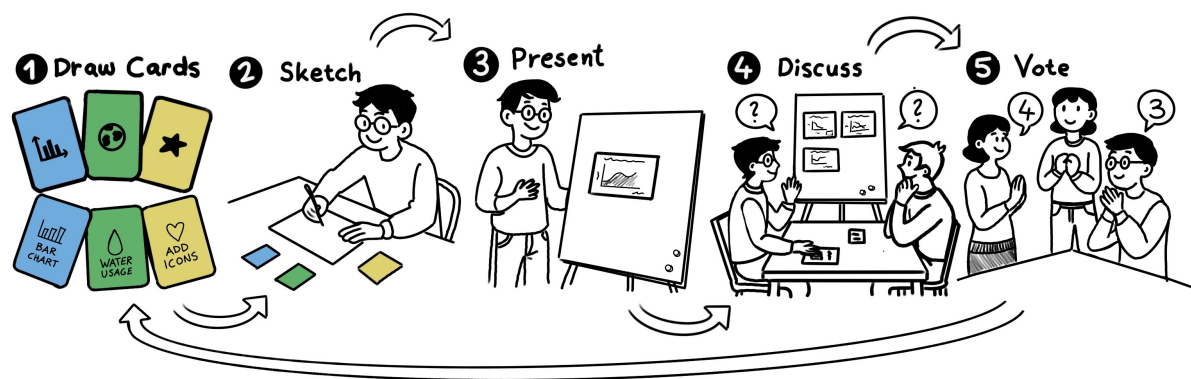# Drawagram: A Game-Based Learning Approach to Teach Time-based Data Visualization

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Figure 1: *Illustration of the process of a round in the card game, showing the steps from drawing cards and sketching a visualization to presenting, discussing and voting*

Abstract
Drawagram is a card game based on creativity and interaction that explores the fundamental ideas behind the development of simple time-based data visualizations. Players create visualizations individually on a range of topics, following the guidelines provided by specific cards. The game encourages creativity and innovative thinking and motivates players to find and try different methods to visualize data successfully. By combining learning with gamification, Drawagram offers students, professionals, and educators a fun and accessible way to improve their data literacy.

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

In today's data-driven world, the ability to understand and interpret data visualizations has become an essential skill in a variety of fields [BMBH16, AGR21, BRBF14]. However, traditional teaching methods often only rely on lectures and software-based training, which might be overwhelming for beginners. To improve engagement and accessibility, researchers emphasize that the importance of including diverse learning materials should not be underestimated, especially in the context of data visualization [BKR*24], and that, in addition, non-computer-based tools such as sketching also provide valuable opportunities for students to be creative [RBB*22].

Gamification has emerged as an effective approach to improve learning outcomes, particularly in data visualization education [CRA*18, GWL*19, ARC*17]. Studies suggest that using a game-based approach to learn different data visualization methods is an accessible and straightforward way to teach the general public basics of visual representation and its appropriate use [AGR21].

Some card games exist, such as "Charty Party" [Cha25], "The Graphic Continuum: Match it Game" [SR25], and "The Data Visualization Deck" [Paj25] that reach from purely entertaining party game to visualization cards that support professionals to improve their work and achieve a compelling presentation of their data.

Building on the success of these existing card games, we intro-

duce *Drawagram* and take a step further by focusing specifically on time-oriented data visualizations, offering a more interactive approach. *Drawagram* is a hands-on educational card game that supports users in engagingly discovering time-oriented data visualization. By allowing players to experiment with different chart types and relevant topics and engage in discussions about their created visualizations, *Drawagram* fosters creativity and analytical thinking. The game encourages players to make quick, informed decisions about how to structure their visualizations and also to reflect on how effective their design decisions are.

Currently, *Drawagram* focuses on creating simple time-based data visualizations to help players develop a basic understanding of how to represent data over time. The game is designed for students, educators, and professionals to provide an engaging way to explore the basic principles of data visualization. Through game-based learning, *Drawagram* helps players improve their data literacy in a fun and engaging environment.

2. Game Description

Drawagram is a hands-on card game that allows players to explore time-oriented data visualization techniques in an interactive and engaging way. The game consists of three different card types, as illustrated in Figure 2. "Chart Cards" (Figure 2, blue) determine the type of visualization that needs to be drawn, "Topic Cards" (Figure 2, green) specify the topic for the visualization, and "Special Cards" (Figure 2, yellow) introduce constraints or challenges that must be followed when creating visualizations. To ensure fairness, Special Cards have been curated to offer comparable levels of difficulty. While balancing is still ongoing, the current card set is considered to be mostly well-balanced in terms of challenge across players.

Within a time limit of 5 minutes, players use pencils and colored pens to draw visualizations on a sheet of paper based on the cards assigned to them. At the end, all visualizations are presented and discussed. The goal is to encourage visual thinking, problem-solving, and critical evaluation of data representations while providing an entertaining and educational experience.

Drawagram is designed for three to four players and is best played in a small group setting that encourages creativity, peer learning, and constructive feedback.

3. Goals and Rules of Play

The goal of the game is to create the most effective, creative, and accurate sketch of a data visualization within 5 minutes. While sketching, players must carefully consider what data they want to display that fits the given theme and chart type while following the constraints imposed by the "Special Cards" (see Figure 2, yellow card). After each round, all visualizations are presented and discussed. The group will evaluate each visualization based on three criteria: (1) creativity, (2) accuracy, and (3) legibility. The player with the best overall score in these three categories earns a point. The game continues until a player has earned three points or an agreed number of rounds has been played.

Figure 2: *Examples of the Card Types in Drawagram. The blue "Chart Cards" determine which visualization has to be created, the green "Topic Cards" define the subject of the visualization, and the yellow "Special Cards" introduce constraints that need to be followed by the players when creating.*

4. Game Manual

Each round of the game consists of 4 key phases: Setup, Sketching, Presentation and Discussion, and Voting, as illustrated in Figure 1.

4.1. Setup

At the beginning of each round, the group draws one "Chart Card" and one "Topic Card" collectively. The "Chart Card" specifies the type of visualization that must be used, and the "Topic Card" defines the subject for the visualization. Based on these two cards, all players must create their visualizations.

In addition to these shared cards, a "Special Card" is drawn by each player individually. This card introduces constraints or challenges that must be included in the visualization, such as "add a legend," "highlight anomalies," or "use at least three different colors". These constraints encourage players to experiment with different techniques and ensure that there will be a wide variety of visualizations to discuss.

Players unfamiliar with the drawn chart type can find a short description in the added booklet, which contains an illustration and a brief description of each chart type included in the game. This ensures that all players can participate effectively and understand how to represent data in the given format.

4.2. Sketching Phase

Once the cards have been drawn and each player understands the drawn chart type, the timer is set for 5 minutes. During this time

period, each player must create a sketch of a visualization on paper using pencils and colored pens. The sketch must align with the given chart type and topic and has to include the restriction from the individually drawn "Special Card".

The game focuses on creativity, not artistic skills. Players should think about how to communicate data effectively using the given visualization method. The short time limit adds some challenge to the whole sketching process, as players are pushed to make quick but thoughtful decisions.

4.3. Presentation and Discussion

As soon as the timer runs out, each player takes turns and presents their visualization to the group by explaining the reason behind their design choice, how they incorporated the restriction of the "Special Card", why they selected specific colors or labels, and what story or message the visualization should convey. After each presentation, the group discusses the outlined visualization based on factors such as creativity, clarity, accuracy, and legibility. This discussion should encourage the players to reflect on what was done well and what could be done better. The whole process is non-judgmental and intended to foster learning and the exchange of insights.

4.4. Voting Phase

After the group presents and discusses all sketches, the sketches will be evaluated. All players evaluate each visualization individually based on the factors of creativity, accuracy, and legibility. Players cannot vote on their own sketches.

Creativity assesses how unique and interesting the approach is. Accuracy checks that the chart type has been implemented correctly and displays the data accurately while taking into account the limitations of the "Special Card". Legibility determines if the visualization is easy to understand, with clear titles, axis labels, and other important elements.

Each player assigns a score from 1 (Very Poor) to 5 (Excellent) in each category for every other player's visualization. The scoring is based on the Likert scale outlined below:

Score	Description
1	Very Poor
2	Below Average
3	Average
4	Good
5	Excellent

Table 1: *Likert Scale for Evaluating Visualizations*

Each player's total score is calculated by summing the points they received across all criteria from the other players. The player with the highest total score at the end of the round wins and earns a point.

Voting is conducted openly, and players are encouraged—but not required—to briefly explain their given scores. This promotes reflection and constructive feedback. If two or more players have the same number of points at the end of a round, they will all earn a point. The game continues until a player reaches three points or until a predefined number of rounds has been played.

To simplify the evaluation process, players can use the Drawagram voting sheet. This is a structured sheet on which all ratings can be noted during the voting phase. This contributes to transparency, avoids errors, and simplifies the final score calculation.

5. Example Round of the Game

To illustrate how a game of Drawagram plays out, this example describes a round with three players: A, B, and C.

5.1. Setup

The following cards are drawn for this round:

- Chart Card: Spline Chart (same for all players)
- Topic Card: Water Usage (same for all players)
- Special Cards:
  - Player A: Label at least 3 data points
  - Player B: Use at least 2 different colors
  - Player C: Use time intervals in months

Each player must therefore create a spline chart about water usage over time, while also meeting the unique constraint on their "Special Card".

5.2. Sketching Phase

A 5-minute timer is started. Players sketch a chart that displays data related to the previously selected topic using paper, pencils, and colored pens.

Possible ideas could be:

- Daily household water consumption over a week.
- Seasonal variations in a city's water usage.
- Global water usage by different sectors over time.

Using pencils and colored pens, the players create spline graphs, ensuring they meet the requirements of the special card assigned to them and show suitable data for the chosen topic. The data does not need to be factually accurate, but should fit the theme in a plausible or illustrative way.

Player A decides to sketch a spline chart based on global water usage by different sectors over time (see Figure 3).

Player B creates a spline chart showing per capita water usage across decades on different continents, using at least two different colors to differentiate between regions (see Figure 4).

Player C sketches a spline chart visualizing the water usage of an average household in Germany across the year, using monthly time intervals from January to December. (see Figure 5).

5.3. Presentation and Discussion

Once the 5-minute time period is over, each player presents their visualization separately. This could proceed as follows:
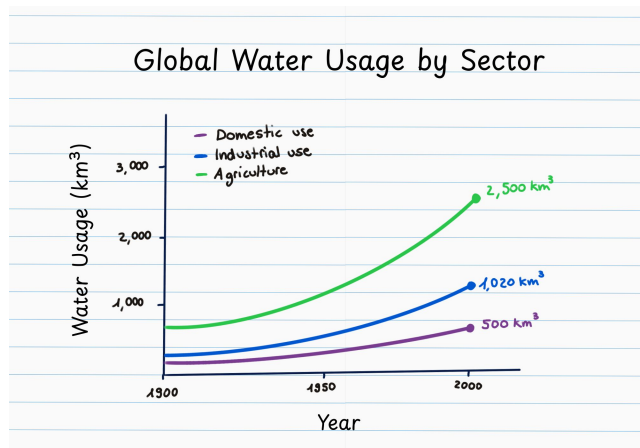
Figure 3: *Example of a sketched data visualization of Player A based on the Chart Card: Spline Chart, Topic Card: Water Usage, and Special Card: Label at least 3 data points.*
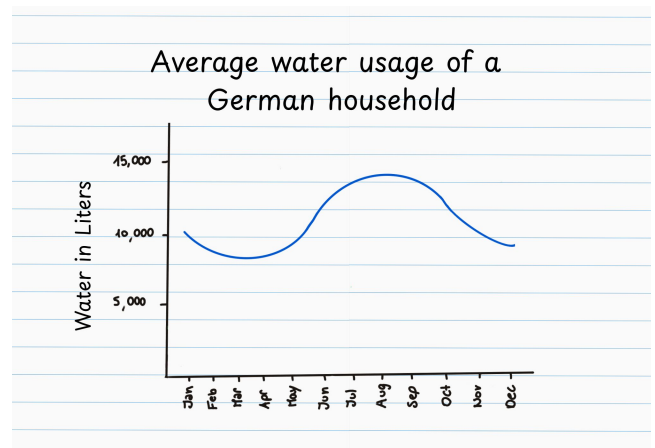
Figure 5: *Example of a sketched data visualization of Player C based on the Chart Card: Spline Chart, Topic Card: Water Usage, and Special Card: Use time intervals in months.*
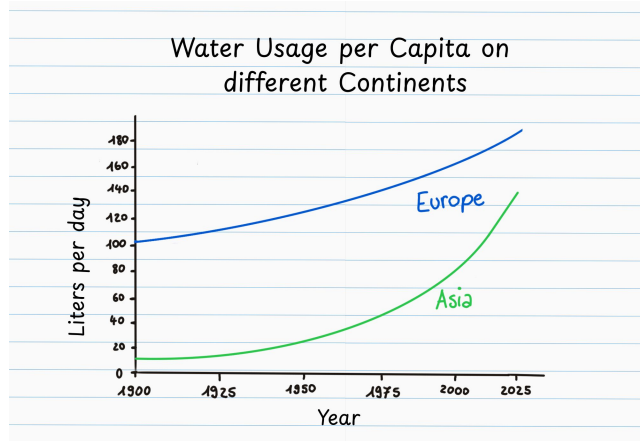
Figure 4: *Example of a sketched data visualization of Player B based on the Chart Card: Spline Chart, Topic Card: Water Usage, and Special Card: Use at least two different colors.*

Player A – Presenter: Label at least three data points

Player A: "My chart shows global water usage by sector from 1900 to 2000. I used green for agriculture, blue for industry, and purple for domestic use. As required by my Special Card, I labeled three data points from the year 2000. I also included a title, axis labels, and a legend."

Player B (Providing Feedback):"The colors work well. Maybe labeling a mid-century value like 1950 would better show the growth trend."

Player C (Providing Feedback): "The message is clear. Adding grid lines and using the right color order in the legend could improve the readability."

Player B – Presenter: Use at least two different colors

Player B: "I created a spline chart showing per capita water usage in Europe and Asia from 1900 to 2025. I used blue for Europe and green for Asia to fulfill my Special Card. The lines show how Europe's usage increased slowly while Asia's increased sharply after 1950. I wanted the contrast in color to help highlight the regional differences more clearly."

Player A (Feedback): "The color use works well, and the regional comparison is clear. Maybe labeling some data points for each region directly on the chart would help make it even more readable."

Player C (Feedback): "Color coding by region works well, maybe add some grid lines for better readability of in between values."

Player C – Presenter: Use time intervals in months

Player C: "I visualized household water usage over the course of one year for an average German household. I used a solid blue line to show the total water consumption per month. As you can see, usage increases during the summer months, likely due to gardening and outdoor activities, and is lower in winter."

Player A (Feedback): "The chart is easy to follow. Adding exact values to highlight the peak or lowest months might make the trend even clearer."

Player B (Feedback): "I like the seasonal pattern. Including a simple legend or annotation for the summer peak could reinforce the interpretation."

5.4. Voting Phase

The voting phase will begin once all the sketches have been presented and discussed by the group. Each player evaluates the other

players' visualizations based on three categories: creativity, accuracy, and legibility. The evaluation follows a Likert scale, as outlined in Table 1, where players can assign a score between 1 (lowest score) and 5 (highest score) for each category. To help keep track of the ratings, players can use the provided voting sheet, which includes a table for player and category and space to sum up the scores. Players do not rate themselves. The players rated the visualizations as follows:

Player A receives:

- From B: Creativity 4, Accuracy 4, Legibility 3
- From C: Creativity 4, Accuracy 4, Legibility 3
- **Total: 22 points**

Player B receives:

- From A: Creativity 3, Accuracy 3, Legibility 3
- From C: Creativity 4, Accuracy 4, Legibility 4
- **Total: 21 points**

Player C receives:

- From A: Creativity 3, Accuracy 3, Legibility 4
- From B: Creativity 2, Accuracy 4, Legibility 4
- **Total: 20 points**

Winner of the round: Player A

The game then continues until a player reaches three points or until a predefined number of rounds has been played.

6. Usage and Future Variations

Drawagram has been designed as a hands-on learning tool for use in classrooms, workshops, and training sessions. It supports learners in understanding and applying the fundamentals of time-based data visualizations through play and creativity.

Currently, *Drawagram* focuses primarily on creating simple time-based data visualizations to help players develop a basic understanding of how to represent data over time. Future versions of the game may include more advanced visualization methods and chart types with additional functionalities, such as bar charts for categorical comparisons, scatter plots for correlations, and pie charts for ratio-based comparisons. In addition, complex visualizations such as stacked area charts for cumulative trends, radar charts for multi-variable comparisons, and Sankey diagrams for flow visualization could further enhance the gaming experience.

6.1. Preliminary Evaluation

To gain initial insights into its educational effectiveness and engagement, a field study was conducted with 22 Master's students in Digital Business Communications at UAS St. Pölten. During a structured session, participants were introduced to the rules and goals of the game and played two full rounds of the game in small groups.

A pre-game questionnaire revealed that most participants had limited experience with time-based visualizations: 63.6% had created only simple charts, 31.8% had never created a time-based data visualization by themselves and only 4.5% stated that they have

created multiple ones. Confidence levels regarding creating one's own time-based data visualizations were rated at an average of 2.82 out of 5. After playing, this increased to 3.41, suggesting that the game contributed to improving participants' self-perceived ability to create and evaluate visualizations.

To measure engagement, the *VisEngage* [HP17] framework was used, with scores in 11 different dimensions rated on a 15-point scale. The following values represent the average ratings from all 22 participants. The highest-rated dimensions were Aesthetics (12.73), Autotelism (12.41), and Novelty (11.59), reflecting the game's visual appeal and intrinsic motivation. Lower scores in Challenge (10.05), Discovery (10.64), and Captivation (10.95) indicated areas where future iterations could incorporate greater complexity and exploratory depth.

Open-ended feedback emphasized the game's clarity, playful structure, and suitability for educational use. Players appreciated the analog format, the time constraint, and the Special Cards for stimulating creative thinking. It was noted, however, that the 5-minute sketching phase might be too short for beginners. Participants recommended extending the time limit to 7 minutes for players with less experience. This highlights the game's flexibility—groups are encouraged to adapt the time limit based on their experience level and learning goals. Additional suggestions for improvement included balancing the difficulty of "Special Cards" and including voting instructions directly on the score sheets.

Overall, all participants expressed that they would recommend *Drawagram* in academic settings, especially as an introductory tool for learning data visualization concepts. The collaborative nature of the game, along with its focus on discussion and reflection, was particularly appreciated.

7. Reflection and Conclusion

Drawagram is an engaging, educational card game that helps transform the learning process of data visualization into an interactive experience. By encouraging critical thinking, storytelling, and creativity, it acts as an effective learning resource for beginners and experienced data enthusiasts by making complex concepts more accessible and fun. The game provides a learning environment that encourages students to experiment with different visualization methods and have valuable discussions about data visualizations.

Nevertheless, some challenges might still be considered regarding the game. Players with limited drawing skills may hesitate to participate, thinking they are not competent enough. Therefore, it should be underlined that the game emphasizes creativity and correct representation over artistic ability. For players unfamiliar with some visualization methods, the "Card Description Booklet" explains each chart type included in the game. This ensures that everyone can participate in the game regardless of their prior level of knowledge. It is also vital to create an atmosphere of positive and constructive feedback in which all players can learn and improve together.

The game may be successful if participants enjoy it and feel that they have gained valuable insights into data visualization from playing it. After the game, participants should feel more comfort-

able creating their data visualizations, as the game provides an engaging and educational experience to improve their data visualization skills.

Drawagram draws inspiration from games like *Charty Party* [Cha25], which also use cards and humor to explore data visualization, and *Viz Futures* [DOW*25], which encourages design thinking through prompts. However, unlike these games, *Drawagram* focuses on sketching, timed challenges, and peer feedback, creating a more hands-on and reflective learning experience. Gamification elements such as randomized card combinations, time pressure, tactical constraints, and a voting-based reward system are used to maintain engagement while reinforcing core visualization concepts [KAWI16].

8. Materials Overview

The game box includes the three different types of cards, which are displayed in Figure 2. The blue "Chart Cards" determine which visualization has to be created, the green "Topic Cards" define the subject of the visualization, and the yellow "Special Cards" introduce constraints that need to be followed by the players when creating their visualizations. The base game consists of 29 playing cards in total. Of which seven are "Chart Cards", eight "Topic Cards" and fourteen "Special Cards". Additionally, a card-sized Instruction is included to provide a quick overview of the rules and gameplay structure. A "Chart Description Booklet" is provided, giving clear explanations and examples of all the different chart types found in the game. A structured "Voting Sheet" is also included to help players record and total scores during the evaluation phase.

While the game box contains all the essential components, some additional materials are required for the game. These include paper, pencils, erasers, and colored pens or markers for sketching the visualizations. A timer (e.g., a smartphone stopwatch) is also required to respect the time limit per round.

All printable game materials, including the playing cards, instruction card, voting sheets, and Chart Description Booklet, are provided in the supplementary material.

9. Acknowledgements

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