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Leveraging Popular Board Games to Teach Data Visualization

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Abstract

To address the challenges in visualization education—particularly in motivating and engaging students—we propose the conceptual adaptation of popular board games into educational data visualization games. We present five unique adaptations of well-known board games, integrating their mechanics and materials into a data visualization learning process. For each game, we outline specific learning objectives and suggest strategies to extend the game-based approach to broader data visualization education. By combining familiar, engaging game mechanics with visualization content, we aim to foster critical engagement with the learning material while providing students with a foundational understanding of data visualization concepts. Early qualitative results from one of the games indicate a positive impact on players' learning, boosting engagement and enjoyment.

CCS Concepts

• ***Human-centered computing*** → ***Visualization theory, concepts and paradigms; Information visualization;***

1. Introduction

With the extended use of data visualization in many application fields, data (and) visualization literacy is becoming an essential skill to develop [RR24]. At the same time, visualization education faces several challenges—from assessing educational visualization activities to adapting teaching methods to keep up with the continuous changes in society [BKR*24]. Therefore, identifying novel educational approaches to effectively engage people in learning data visualization is of primary interest to our community.

Several research groups have explored the integration of *gamification* into visualization education to enhance visualization literacy and teach data visualization to audiences (such as children) through educational games. This has led to the development of several innovative tools, such as including an online platform for learning pictographs and bar charts [ARC*17], a 2D educational game to teach charts and diagrams [GWL*19], and a visualization tool grounded in constructivist principles that encourage children to actively engage with the data and mapping processes [BZP*20]. Recently, a taxonomy-driven model for designing educational board games in visualization has also been proposed [AGR21].

We *conceptually explore* how five popular board games can be adapted into educational board games for data visualization. One of those games has been developed and informally evaluated through several game courses. To this end, we have employed what we call an *educational adaptation approach*, drawing on the methods used in our previous work [AGR21]. This approach consists of adapting existing board games to incorporate visualization elements while preserving as much as possible the core mechanics of the original game. Additionally, game design changes are introduced to align with specific learning objectives related to data visualization.

The contributions of this work include (i) the *conceptualization and design* of five board games intended for use in workshops and classrooms as part of educational activities, (ii) the analysis of the proposed board games in terms of their potential effectiveness in meeting *learning objectives* in data visualization, and (iii) the detailed presentation of the *game material design*, showcasing how these games can be utilized to facilitate a deeper understanding of data visualization concepts.

2. Popular Board Games for Data Visualization Education

Although prior research indicates that board games effectively improve academic knowledge and motivation [NNP*24], this assumes that learners possess a level of motivation to engage with educational games and are willing to learn. Additionally, learners may initially face barriers in understanding how to play an unfamiliar game and adapting to its mechanics and design [ATMC17].

This insight motivated us to adapt popular board games for educational purposes in data visualization. Specifically, we selected *Memory* [Wik25b], *Guess Who?* [Wik25a], *Pictionary* [Wik25d], *Taboo* [Wik25e], and *The Chameleon* [Wik25f] to provide a heterogeneous set of games in terms of age range and game mechanics. They all share, though, simplicity in their gameplay and popularity among the general population. This choice allows us to cover multiple learning objectives (see Section 2.1) and generate adaptations of those games (see Section 2.2) as a toolkit to be used in different contexts (e.g., academic and business workshops, K-12 education, etc.), for different purposes (e.g., enhancing data clarity, support-

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ing visualization interpretation, etc.), and with different audiences (e.g., researchers, business professionals, educators and students) interested in enhancing their visualization literacy.

Leveraging games, with which learners are already familiar, can reduce barriers for less motivated individuals, while simultaneously increasing enjoyment and engagement for those who are already motivated. Furthermore, by utilizing the popularity of some games, educational adaptations for the domain of data visualization can contribute to the development of serious games. These games can appeal to a broader audience, including those unfamiliar with visualization concepts, thereby helping to popularize them [ATMC17]. Therefore, selecting classic board games is crucial, as they are widely recognized, allowing players to dive into the experience without wasting time learning game rules. This can make the game more accessible and enhance its overall appeal [ATMC17].

2.1. Learning Objectives

To create the game adaptations for data visualization education, we thoroughly investigated how each selected game could achieve specific learning objectives. For each one, we discussed how the game design and rules could be modified to target various cognitive levels. To guide this process, we utilized Bloom's taxonomy of educational objectives [Blo56], which categorizes cognitive goals into six hierarchical levels. This taxonomy allowed us to systematically assess each game's potential to target and enhance different levels of cognitive engagement and visualization learning outcomes. The six levels of Bloom's taxonomy determine ways to foster the following learning objectives (in increasing cognitive level order and also depicted in Table 1):

- ***Remember*** data visualizations, (i.e., define different data visualizations; list concepts related to data visualizations). At this level, learners are, for instance, able to remember and define what a scatter plot is.
- ***Understand*** data visualizations, (i.e., identify data visualizations; recognize data types, chart types, and visualization tasks; classify different data visualizations; discuss concepts in data visualization). At this level, learners are, e.g., able to understand why a scatter plot is suitable for identifying correlations.
- ***Apply*** data visualization knowledge (i.e., use data visualization taxonomies). At this level, learners are able to ask and answer questions, such as "what is the chart type of scatter plots".
- ***Analyze*** data visualizations, (i.e., compare different data visualizations; distinguish data types, chart types, and visualization tasks; relate data visualizations to visualization requirements; question the use of data visualization in a specific context). At this level, learners are, for example, able to compare a scatter plot with a line chart and tell apart their characteristics.
- ***Evaluate*** data visualizations, (i.e., select the right data visualization for a specific context; justify the use of data visualization in a specific context). At this level, learners are, for example, able to explain why a scatter plot would be suitable for solving a given visualization problem or task.
- ***Create*** data visualizations, (i.e., design data visualizations). At this level, learners are, for example, able to design and craft a complex scatter plot from scratch.

2.2. Educational Adaptation in Data Visualization

In this section, we illustrate the selected popular board games and their corresponding visualization adaptation. Each game is profiled by providing details on the original game and its adaptation, including game duration, number of players or learners, level of accessibility, and associated learning objectives. At the moment, we provide indications for these characteristics, which would need to be formally evaluated in the future. The game duration and number of players are based on the recommendations of the original game's authors. In contrast, we determined the level of accessibility based on the mechanics and design features of the adaptation. Higher accessibility levels indicate that the game does not require players to have visualization literacy skills prior to playing. We do not recommend an age range, being challenging to define at this stage due to varying player abilities, learning curves, and the need for further empirical testing to assess its suitability for different age groups.

2.2.1. Guess Vis?

In the original *Guess Who?* [Wik25a] game, players must ask yes/no questions to discard options and deduce the character to guess to win the game. In our educational adaptation for data visualization, *Guess Vis?* [AGR21], learners must correctly guess the data visualization of their opponent by taking advantage of clues on the data visualization illustrated in each card to ask and answer questions. As the game progresses, players strategically narrow down possibilities by interpreting visual features such as chart types, data types, visual elements, and tasks (see Figure 1 (a)). This encourages learners to develop critical thinking skills in data interpretation while making the process interactive and engaging. This game has been developed (see Figure 2) and tested by playing through multiple play sessions. As a result, its key specifications can be summarized as follows:

- **Game Duration:** 10–20 minutes (estimated).
- **Number of Players:** 2+ players.
- **Accessibility:** High.

Regarding the **learning objectives** that the game supports, we see opportunities to promote the following levels: ***Remember***, ***Understand***, ***Apply***, ***Analyze***, and ***Evaluate***. Players build a strong vocabulary of visualization concepts by forming yes/no questions based on visualization characteristics (i.e., ***Remember***). Through elimination, they differentiate visualization types (i.e., ***Understand***) and apply their knowledge of categories and attributes using card hints (i.e., ***Apply***). Discussions about eliminations reinforce their understanding of how visualizations serve different functions. Players also assess the suitability of visualizations by considering data types, tasks, and critical questions (i.e., ***Analyze***), ultimately identifying the best visualization for a given case (i.e., ***Evaluate***). A mapping of the game to the learning objectives it supports is presented in Table 1, along with an explanation of how these learning objectives are achieved.

2.2.2. VisMemory

In the original *Memory* [Wik25b] game, a number of paired cards are faced down and players have to flip up two cards at a time attempting to match them. The game ends when all cards have

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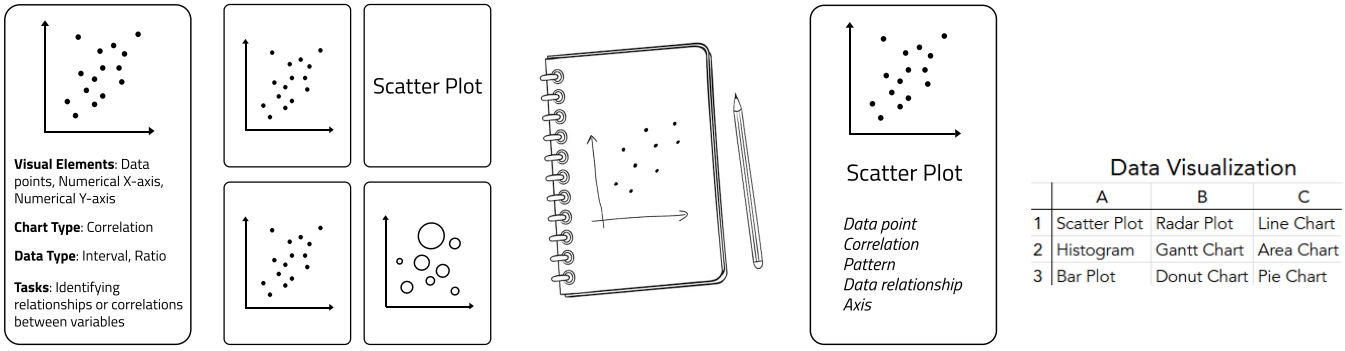

Figure 1: *(a) A* Guess Vis? *card. Clues regarding visual elements, chart types, data types, and tasks are indicated for the selected visual representation—in this case, a scatter plot. (b) A set of* VisMemory *game cards. The top row shows a pair of cards to be matched requiring remembering the data visualization name and its corresponding representation, while the bottom row shows a variant in which data visualizations must be matched according to their chart type. (c) In* PictionaryVis*, players alternate drawing data visualizations for others to guess. (d) A* TabooVis *card, where a visual representation is shown along with related keywords that the learner is not allowed to use while describing it. (e) The* VisChameleon *board is used to select the visual representation and differentiate* VisChameleons *from regular players.*

been matched. Our educational adaptation for data visualization, *VisMemory*, would have two variants (see Figure 1 (b)). The first, basic variant would require matching data visualizations to their name (top pair in Figure 1 (b)). The second, more advanced one, would require matching data visualizations by type (bottom pair in Figure 1 (b)). For instance, a scatterplot would be matched to a bubble chart, as they both represent relationships between two numerical variables using position. Conceptually, its key specifications could be summarized as follows, but these should be further assessed after actual play sessions:

- **Game Duration:** 10–20 minutes (estimated).
- **Number of Players:** 1–2 players.
- **Accessibility:** High.

Regarding the **learning objectives** that the game supports, we see opportunities to promote the following levels: ***Remember*** (only the basic variant), ***Understand***, and ***Analyze*** (only the advanced variant). In the basic variant, players reinforce associations between data visualizations and their names (i.e., ***Remember***) while improving recognition and matching skills (i.e., ***Understand***). In the advanced variant, players use a vocabulary of visualization concepts to match cards (i.e., ***Remember***), enhancing recognition and classification skills (i.e., ***Understand***). Grouping similar charts helps them differentiate types and analyze their characteristics, refining their understanding of how visualizations differ (i.e., ***Analyze***). A mapping of the game (and the skills required from the audience to play) to the learning objectives it supports is presented in Table 1, along with an explanation of how the objectives are achieved.

2.2.3. PictionaryVis

In the original *Pictionary* [Wik25d] game, players take turns to draw regular objects or phrases, while the other players guess what they are drawing and gain points. Our proposed visualization version, *PictionaryVis*, narrows what must be guessed to data visualizations, requiring players to draw a data visualization to be guessed (see Figure 1 (c)). This adaptation challenges players to creatively represent charts, graphs, and other visual encodings using only drawings, reinforcing their understanding of key visualization principles. By interpreting and guessing these drawings, players engage in active learning, improving their ability to recognize and communicate data through visualization. Conceptually, its key specifications could be summarized as follows, but these should be further assessed after actual play sessions:

- **Game Duration:** 30–60 minutes (estimated).
- **Number of Players:** 3+ players.
- **Accessibility:** High.

Regarding the **learning objectives** that the game supports, we see opportunities to promote the following levels: ***Remember***, ***Understand***, ***Analyze***, and ***Evaluate***. *PictionaryVis* reinforces understanding of chart structures as players must draw data visualizations (i.e., ***Remember***) and recognize what is being drawn (i.e., ***Understand***). This leads to conversations about the choices made during the drawing process and different sketches of the same concept, through which players refine their understanding of chart differences and select the correct chart (i.e., ***Analyze***). Ultimately, players must decide on the best representation for the given case (i.e., ***Evaluate***). A mapping of the game to the learning objectives it supports is presented in Table 1, along with an explanation of how these learning objectives are achieved.

2.2.4. TabooVis

The original *Taboo* [Wik25e] is a party game where players take turns describing a word without using a set of related keywords listed on the card, while their teammates try to guess it to gain points. In our adaptation concept, *TabooVis*, each card features a specific data visualization that the player must describe to their teammates without using a set of "taboo" words, i.e., key terms closely associated with that visualization. For instance, they should not use the word "data point", "correlation", "pattern", or "axis" for a scatter plot (see Figure 1 (d)). This constraint encourages players to think creatively about how to convey visual encodings,

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patterns, and relationships in data without relying on common terminology, deepening their understanding of visualization concepts through gameplay. Conceptually, its key specifications could be summarized as follows, but these should be assessed after actual play sessions:

- **Game Duration:** 20–40 minutes (estimated).
- **Number of Players:** 4+ players.
- **Accessibility:** Medium.

Regarding the **learning objectives** that the game supports, we see opportunities to promote the following levels: ***Understand***, ***Apply***, and ***Analyze***. *TabooVis* enables players to enhance their ability to recognize charts through active participation and by listening to explanations (i.e., ***Understand***). Conversations about visualizations occur naturally, allowing players to apply categories during these discussions (i.e., ***Apply***). This active engagement helps players improve their skills in analyzing charts and understanding related concepts (i.e., ***Analyze***). A mapping of the game (and the skills required from the audience to play) to the learning objectives it supports is presented in Table 1, along with an explanation of how these learning objectives are achieved.

2.2.5. The VisChameleon

In the original *The Chameleon* [Wik25f] game, all players, except for the "Chameleon(s)," are secretly assigned a word. Players take turns providing one-word clues related to their word, aiming to be subtle. Meanwhile, the Chameleon(s) must guess the secret word without being detected by the others. At every turn, one player is eliminated by mutual agreement. If the Chameleon(s) manage to remain undetected, they win; if not, the other players win. In our visualization variant, *The VisChameleon*, learners try to figure out a secret data visualization instead of a casual word to win the game (see Figure 1 (e)). For instance, players provide one-word hints related to a specific data visualization, such as "bars" for a bar chart or "hierarchy" for a tree map, while the VisChameleon attempts to blend in without knowing the correct visualization. This variation reinforces players' ability to recognize and describe key visualization features while adding an element of strategic thinking to the learning process. Conceptually, its key specifications could be summarized as follows, but these should be formally assessed after actual play sessions:

- **Game Duration:** 15–30 minutes (estimated).
- **Number of Players:** 3–8 players.
- **Accessibility:** Low.

Regarding the **learning objectives** that the game supports, we see opportunities to promote the following levels: ***Understand***, ***Apply***, ***Analyze***, ***Evaluate***. By blending in and actively engaging in conversations to defend their answers, players participate in discussions that deepen their understanding of visualization concepts (i.e., ***Understand***). By justifying how a visualization fits a particular category, they apply their knowledge of visualization taxonomies (i.e., ***Apply***). In *The VisChameleon*, players also contrast different charts and associate them with categories to identify inconsistencies and to spot the "VisChameleons" which helps to develop differentiation skills (i.e., ***Analyze***). Throughout the game, players continuously challenge each other's explanations and argue why their descriptions make sense, fostering critical thinking and deep understanding (i.e., ***Evaluate***). A mapping of the game (and the skills required from the audience to play) to the learning objectives it supports is presented in Table 1, along with an explanation of how these learning objectives are achieved.

3. Overview of Games Materials

The materials required to play the visualization board games are primarily limited to cards, except for *Guess Vis?* and *PictonaryVis*. These require a board to hold the cards (see Figure 2), and a pencil and paper to draw, respectively. In *VisMemory*, the card deck can be adapted depending on the level of accessibility and learning objectives the game should achieve (see Figure 1 (b)). The cards in *Guess Vis?* and *TabooVis* are more sophisticated, incorporating clues that require prior knowledge of data visualization to interpret effectively (see Figure 1 (a) and (d)). In *The VisChameleon*, players rely on a set of cards (or a simple paper-based game board, see Figure 1 (e)) to determine the secret visualization and identify the VisChameleon. In *PictionaryVis*, cards indicate which type of data visualization a player must draw.

The recommended deck size varies across games. *Guess Vis?* benefits from a deck of 15 to 25 cards to maintain a balanced gameplay experience. In *VisMemory*, the number of cards can range from 20 to 40 cards (i.e., 10 to 20 pairs of cards) to be matched based on the desired difficulty level. In contrast, *TabooVis*, *The VisChameleon*, and *PictionaryVis* do not have a strict upper limit, allowing for an expandable collection of visualizations based on learning objectives. As all proposed games are card-based, complex boards, tools, or tokens are not required. This makes the materials easy and affordable to create using basic crafting supplies such as pens, paper, and cardboard. Furthermore, visualization educators can tailor the chart selection based on their curriculum needs and customize the card design. For example, by extending the card decks with additional cards representing more advanced data visualizations, visualization educators can ensure that the game covers new data visualization concepts and adapts it to better support and reflect the content of their lesson plans or workshops. This flexibility allows for continuous adaptation, making these games a versatile tool for teaching data visualization.

Figure 2: *The game material of* Guess Vis? *includes two boards and two decks of 20 cards each.*

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4. Reflections and Conclusions

We envision that applying educational adaptation to popular board games can have positive effects on visualization learners as the derived educational board games can increase learners' engagement and motivation. The popularity of the games can shorten the time needed to start playing and improve the focus and involvement of the learner in the game activity. This also makes the game more appealing to a broader audience beyond people concerned with data visualization, allowing players to connect with it more easily and actively engage in an educational visualization experience. Additionally, selecting social/party games such as *Pictionary* and *Taboo* is optimal to naturally stimulate discussions on visualization concepts among the learners during the game activity and the development of communication skills.

We acknowledge that most of our proposed games use visualization primarily as content rather than as part of the core game mechanics. Future iterations could explore game designs where visualization itself drives gameplay, such as sketching visualizations to convey concepts, encouraging deeper engagement with visualization as a communicative and interpretive tool. Moreover, adapting more sophisticated board games allows game designers to create experiences that support advanced learning objectives. This is especially true when adapting role-playing games for visualization education, as their narrative-driven design helps enhance learner engagement [HNGC21]. Additionally, such adaptations can facilitate solving real-world tasks through purpose-built design features tailored to specific learning goals [NNP*24]. One example of a sophisticated visualization-based adaptation could be *Monopoly* [Wik25c]. In the visualization variant, learners could for instance focus on completing tasks to develop data visualization skills, rather than purchasing properties and accumulating wealth.

Guess Vis? stands out among the five games as the only one already designed [AGR21] and informally tested with diverse players, providing valuable feedback for refining its mechanics and educational effectiveness. We observed that layplayers became engaged during the game by spontaneously discussing and asking questions about the game material, going beyond just focusing on winning. While this provided preliminary insights into learner engagement and interaction, a formal evaluation is planned for future work—also for the other games. The current paper's focus is on concept development, with *Guess Vis?* serving as a benchmark for future implementations.

To evaluate whether the learning goals of any of the board games are met, studies should measure both participants' engagement and knowledge retention. These studies could include pre- and post-game assessments (e.g., using the miniVLAT [PO23]) to gauge improvements in visualization skills, such as understanding different chart types. Additionally, observing player interactions during gameplay could provide insights into how well the educational objectives are achieved, for instance, how effectively players interpret visual clues or work collaboratively to solve visualization challenges. This data would help determine the games' impact on learning outcomes as well as their key specifications.

Finally, the proposed adaptations tend to focus on basic cognitive skills and may not be well-suited for achieving higher-level learning goals, such as data analysis or critical thinking. While these games can teach basic visualization recognition, they lack depth in more complex skills like evaluating or creating visual representations, i.e. the ***Evaluate*** and ***Create*** levels of Bloom's taxonomy. To bridge this gap, extensions or combinations of existing formats could be explored.

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Table 1: *The mapping of our adapted board games to their corresponding learning objectives. The learning objectives associated with each game are labeled with* **X**, *while the required skills to play it are marked with* **R**. *Additionally, an explanation is provided of how the game achieves each learning objective.* ***Create*** *has not been included as it was not employed for any of the games.*

	Remember data visualizations		Understand data visualizations				Apply data visualization knowledge	Analyze data visualizations				Evaluate data visualizations	
	Define different data visualizations	*List concepts related to data visualization*	*Identify data visualizations*	*Recognize data types, chart types, and vis tasks*	*Classify different data visualizations*	*Discuss concepts in data visualization*	*Use data visualization taxonomies*	*Compare different data visualizations*	*Distinguish data types, chart types, and vis tasks*	*Relate data visualizations to vis requirements*	*Question the use of a data visualization in a specific context*	*Select the right data visualization for a specific context*	*Justify the use of a data visualization in a specific context*
Guess Vis?	X	X	X	X	X	X	X	X	X	X	X	X	
	Players refine their questions based on characteristics of visualizations, learning the definitions.	Players develop a vocabulary of visualization concepts while forming their yes/no questions.	Players determine which visualization their opponent has by asking questions.	Players analyze features to differentiate between types of visualizations.	The game inherently involves classification by elimination.	Players discuss why they eliminated certain visualizations.	To ask effective questions, players apply knowledge of different visualization categories.	Players analyze how one visualization differs from others based on their attributes.	Players refine their understanding of how different visualizations serve different functions.	Players determine which visualization fits the dataset by considering requirements like data type and tasks.	Players can verify if a visualization is or isn't appropriate by asking critical questions.	By eliminating incorrect options, players identify the most suitable visualization for a given case.	
VisMemory - Basic	X		X										
	Playing the game reinforces the association between the data visualization and its name.		Matching reinforces recognition skills.										
VisMemory - Advanced	R	R	X	X	X			X	X				
	Players must know different data visualizations.	Players must have a vocabulary of visualization concepts to match the cards.	Matching reinforces recognition skills.	Matching similar charts strengthens recognition.	By matching charts per chart type, players improve their data visualization classification skills.			Players analyze how one visualization differs from others to match them.	Players learn differences through matching.				
PictonaryVis	X		X			X		X	X	X		X	
	Drawing reinforces understanding of chart structures.		Players recognize what is being drawn.			Conversations emerge about drawing choices.		Players discuss different sketches of the same concept.	Players refine their understanding of chart differences to draw the right chart.	Players choose the right chart based on given data.		Players must decide the best representation.	
TabooVis	R	R	X	X		X	X			X			
	Players must be able to explain data visualizations in their own words.	Players must have a good vis vocabulary.	Players recognize charts by actively participating.	Players recognize charts-related concepts through actively listening the explanations.		Conversations about visualizations happen naturally.	Players apply making use of categories during the explanations.			Players improve analyzing charts by actively participating.			
The VisChameleon	R	R	R	R	R	X	X	X	X	X	X		X
	Players must be able to explain data visualizations in their own words.	Players must have a good vis vocabulary.	Players must recognize a chart to blend in.	Players must understand chart characteristics to avoid being caught.	Players must be able to correctly associate categories to data visualizations.	Players engage in conversations to defend their answers.	Players justify how a visualization fits a category.	Players contrast different charts to identify inconsistencies.	Spotting the chameleon develops differentiation skills.	The VisChameleon associate charts to categories to guess the chart.	Players challenge each other's explanations.		Players argue why their description makes sense.

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