Exploring Open-Ended Question-Asking via an Online Gaming Environment

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THE COGNITIVE COMPLEXITY LABORATORY

Introduction

Studying question-asking is challenging in traditional lab settings, which often fail to reflect real-world context

Games provide intuitive, engaging settings which sustain attention and collect large and high-quality data

We developed **The Martian Game**: An open-ended online question-asking game simulating open-ended problem solving in naturalistic contexts

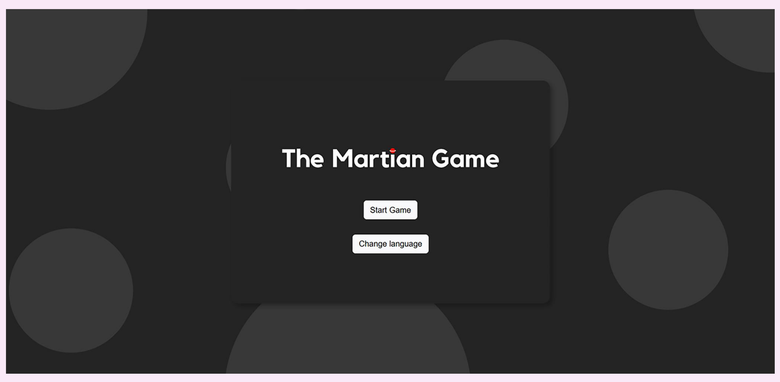
Study Design

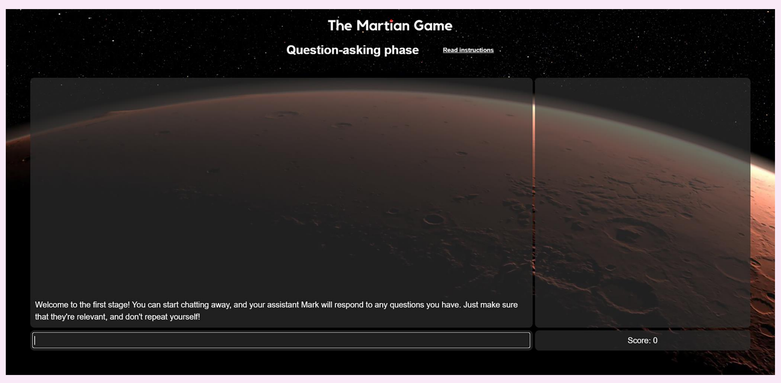
Participants: 105 participants (49 females, mean age = 37.16 years, SD = 12.20 years) collected online via Prolific

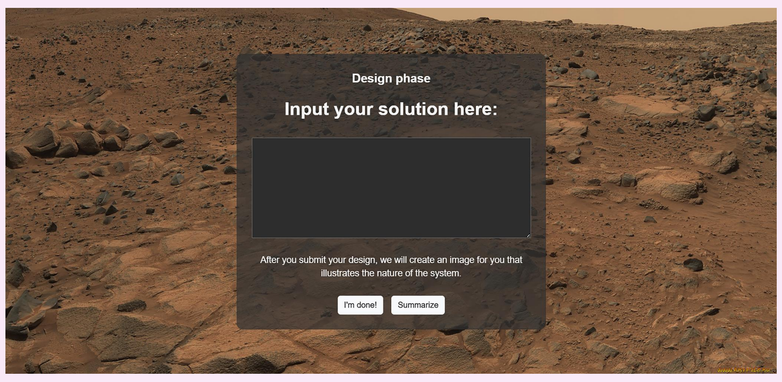
Layout: Relating cognitive abilities measured via traditional lab cognitive tasks (intelligence, creativity, curiosity and question asking abilities) with game performance

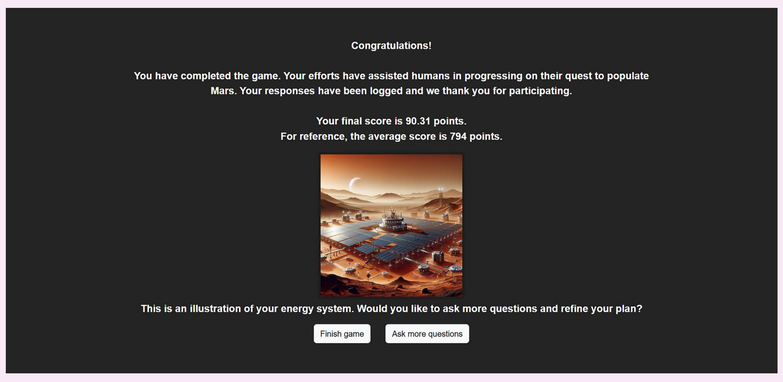
GPT prompt: An extensive prompt was developed for GPT-4o to cover all aspects of the game

The Martian Game









Goal: Designing an energy system for a city on Mars

(Top left) Opening screen

(Top right) Problem finding phase: players ask an AI chatbot ("Mark") questions to gather information and scored on **problem finding** abilities

(Bottom left) Problem solving phase: players propose a solution and scored on **problem solving** abilities

(Bottom right) Finishing screen: a visualization of the solution and final score

Assessing Problem Finding

Questions properties calculated by GPT – complexity, relevancy, consistency, representativeness and coverage

Question type classified by GPT as exploratory, analytical, creative, directive or follow-up

Questions Forward Flow measures the average similarity between player's questions, calculated via SBERT

Assessing Problem Solving

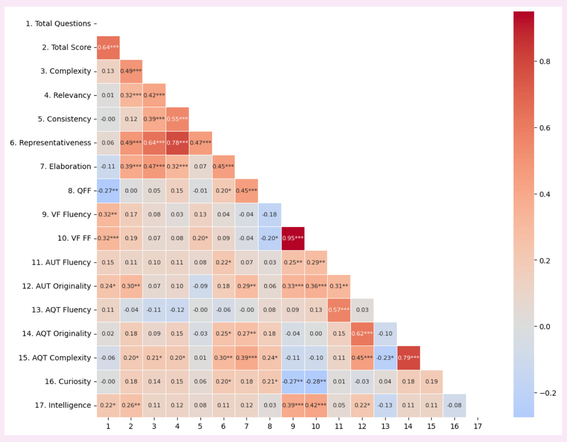
Distances between four solution templates and player's solution calculated by both GPT and SBERT

Min-QA and **Max-QA** measure the semantic distance between player's questions and solution, calculated by SBERT

Divergent semantic integration and **solution originality and quality** calculated by pre-trained LLMs

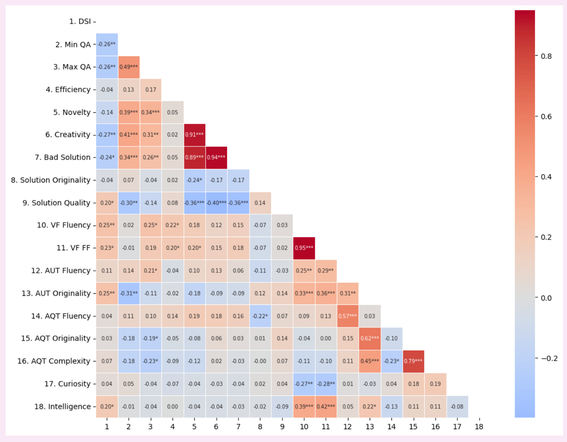
Results

Problem Finding



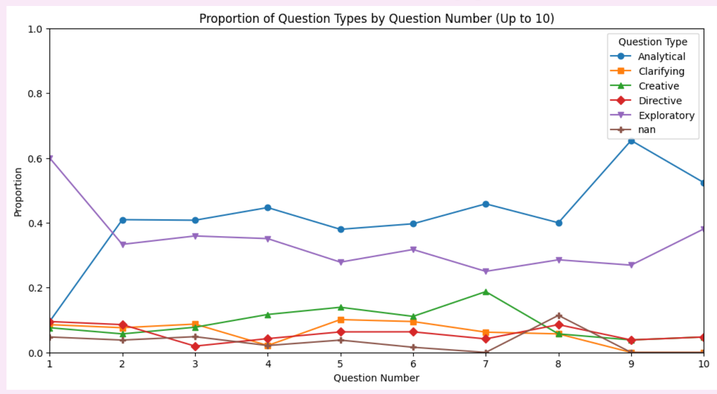
Total score in the game was related to creativity, intelligence, and question-asking complexity; questions dynamics to curiosity and question-asking complexity

Problem Solving



DSI positively related to creativity and intelligence; Min-QA and Max-QA negatively related to creativity and question asking abilities

Type of Questions



Most players ask exploratory questions first and after that, throughout the rest of the game, they ask less exploratory and more analytical questions

Mediation Analysis

General ability to ask questions mediates the relation between general creativity and the creativity of the solution proposed by the player in the game

Conclusions

The Martian Game provides a flexible framework for studying open-ended question-asking across problem domains in naturalistic settings

Creativity, intelligence, curiosity, and question asking capacities facilitated gameplay and creative problem solving

Play

Conference Paper

Poster

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