

Serious Games in Computer Science Education – Playing Games in a Data Structures and Algorithms course

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Introduction

- Serious games
 - Also other objectives than entertainment
 - Include all aspects of education: teaching, training, informing
- Why?
 - Games can be very motivating
 - Students already learn a lot by playing games
 - Games and puzzles can improve problem solving skills
- Why not?
 - Not suitable for everyone
 - 2 typical problems:
 - Fail to integrate educational aim to the game (just add game elements in an educational tool)
 - Game can be played without understanding the learning objectives

Serious Games in CS Education

- Games can be used in various ways:
 - Implementing a game as a programming assignment
 - Implementing a critical aspect of a game
 - Writing a program that acts as a player
 - **Playing a game**
- There are a lot of game-like elements in computer science
 - Data structures, algorithms, error detection...
- Example: Computer Science Unplugged
 - Created by Tim Bell, Ian H. Witten and Mike Fellows
 - A collection of learning activities (off-line games, puzzles, cards...)
 - Especially for young students

Data Structures and Algorithms course

- Programming courses: CS1 (Java), CS2 (Java)
- Data Structures and Algorithms course
 - 100 CS major students
 - 300 other students
- Course consists of:
 - Lectures
 - Automated algorithm simulation exercises (TRAKLA2)
 - PeerWise (multiple-choice questions)
 - Lab-sessions (only CS major students)
 - Programming and analytical exercises
 - Project work (not CS major students)

Advanced programming students (pilot)

- 20 1st year students
- Programming + Data Structures and Algorithms courses
- Programming competitions theme:
 - Weekly lab sessions
 - Old programming competition exercises
 - ACM ICPC (International Collegiate Programming Contest)
 - Project Euler
 - Practicing competition
 - In groups of 1-3 students
 - Substitutes course exam

Games at the Data Structures and Algorithms course

- Games were used for the first time this year
 - CS major + Advanced programming students
- 1 exercise session (total of 36 students, 3*2h)
- Groups of 3-5 students
- 4 games:
 - SortingGame
 - SortingCasino
 - Secret rule
 - Draw and guess
- Feedback

SortingGame

- Cardgame for 2-6 players
- Game about sorting algorithms and related concepts
- 2 decks: algorithms and special
- Special card round
 - Place down a special card ("stable", "in-place", " $O(N \log N)$ ",...)
- Algorithm round
 - Play one algorithm that satisfies all the criteria on the table
 - The algorithm with the best worst case complexity wins the round
 - You can try to slip in an incorrect card → others have to notice
 - Robbery cards

SortingCasino

- Same card decks with SortingGame
- Place 6 cards on the table
- 4 hand cards for each player
- Take all matching cards from the table with 1 hand card
- ... or place one card on the table
- Clear the table and get bonus points

Secret Rule

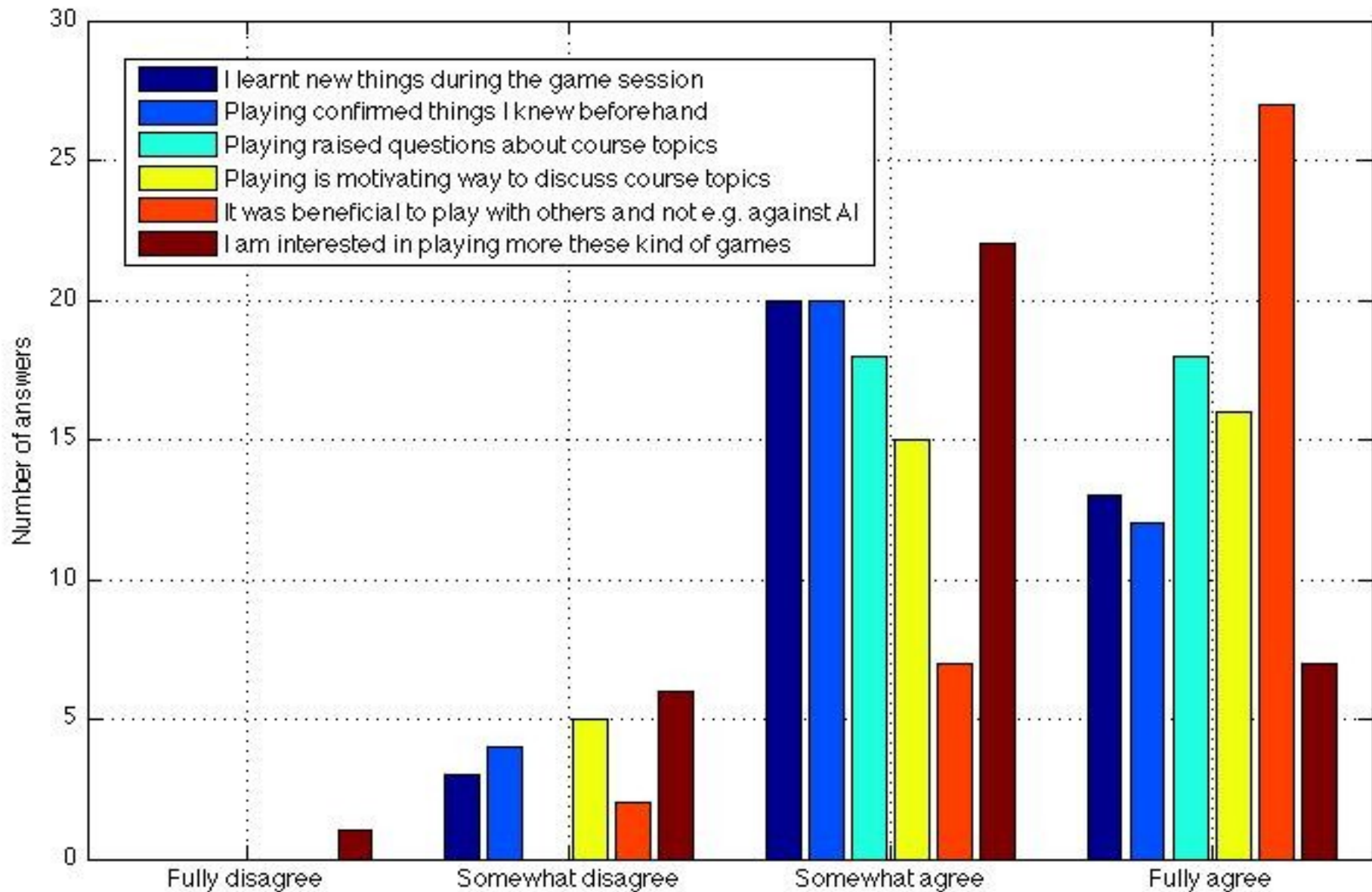
- Cards including course topics + algorithm cards
- One player makes up a secret rule
 - "Linear data structure"
 - "Is related to graph traversal"
 - "In-place sorting algorithm"
- Others try to guess the rule by playing cards on the table
- Dealer acts as a judge for played cards
- The winner is the player who gets rid of all hand cards or guesses the secret rule

Draw and Guess

- A deck of cards with data structures and algorithm concepts
- 2 teams
- A player draws the concept on the board
- Own team has 30s time to guess
- +30s time for all teams to guess

Overall results

- A) Games don't seem to be a sensible teaching method even if they are developed further (3%)
- B) Games didn't work well now, but in principle they seem like a sensible teaching method, if they are developed further in a right direction (3%)
- C) Games are already a sensible teaching method in the course, but some of their features should be improved notably (56%)
- D) Games are already a sensible teaching method in the course and they don't need any drastic changes, at most some small refinements (35%)
- E) Something else (3%)



Lessons learned

- Overall ratings (from 1 to 5):
 - SortingGame: 3,5
 - SortingCasino: 3,5
 - Secret rule: 3,5 (only 4 students played this game)
 - Draw and guess: 3,4
- Rules need refining (and maybe simplification)
- Secret rule is too intimidating and hard
- Draw and guess needs more content (e.g. definitions)

Future

- Promising experience
- Integrated more to teaching
- More games
- Different gaming possibilities
 - Exercise sessions
 - Game room
 - Online games
- Research setting for evaluating the results of playing the games

Thank you!