



Individualizing Learning Games:

Incorporating the Theory of Multiple Intelligences in Player-Centred Game design

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The Theory of Multiple Intelligences (MI)



"An intelligence is the ability to solve problems, or to create products, that are valued within one or more cultural settings" ~ Howard Gardner ~ 02



Eight dimensions of intelligence

Everyone possesses every intelligence but to different degrees. All dimensions work together in an orchestrated way

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The capacity to conceptualize the logical relations among actions or symbols

The ability to use one's whole body, or parts of the body, to solve problems or create products



Sensitivity to rhythm, pitch, meter, tone, melody and timbre

The ability to conceptualize and manipulate large-scale spatial arrays, or more local forms of space

Objective

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To investigate how to perform individualization based on players' intelligences (according to MI); and if the result of this individualization would have a positive impact on the game experience and learning outcome of the players



Sajjadi, et al., "Relation Between Multiple Intelligences and Game Preferences: an Evidence-Based Approach" ECGBL2016 Sajjadi, et al., "Evidence-Based Mapping Between the Theory of Multiple Intelligences and Game Mechanics for the Purpose of Player-Centered Serious Game Design" VSgames2016





Results of the Survey

| | Game Genre | Game Title | Linguistics Logical- Mathematical Visual-Spatial | | Bodily- Kinaesthetic | Musical | Interpersonal | Intrapersonal | Naturalist | |
|--|------------------|-------------------|---|------|-------------------------|---------|---------------|---------------|------------|-----|
| | | Portal | + * | + ** | | | 1 | | + ** | |
| | | Angry Birds | + * | | | + ** | | + * | | |
| | | The Room | + * | | + ** | | | | | |
| | Puzzle | 2048 | - * | + ** | + * | | | | - * | |
| | _ | Tetris | | | | + ** | | + * | | |
| | | Where's My Water? | | | | + ** | + ** | + * | | |
| | | Scribblenauts | | | | | | | + * | |
| | (| Wordfeud | | | | | | | | - * |
| | (word)puzzie | Wordament | | - * | | | | | - * | |
| | Puzzle/action | Braid | + ** | + ** | | | | + * | | + * |
| | Action | Street Fighter | + * | | | | - * | | | + * |
| | Action (sandbox) | Minecraft | | | + * | + * | | | | |
| | | | | | | ** □ | | | * D < 0 | 05 |

Explicit Preferences for Genres

| Game genre | Linguistics | Logical- Mathematical | Visual-Spatial | Bodily- Kinaesthetic | Musical | Interpersonal | Intrapersonal | Naturalistic | |
|---------------------|-------------|--------------------------|----------------|-------------------------|---------|---------------|---------------|--------------|--|
| Action/adventure | | 095* | | | +.115* | | | | |
| Adventure | | | | | | | | +.112* | |
| MMO | | | | | | | | | |
| Platform/platformer | | | | | +.145** | | | | |
| Puzzle | | | | +.146** | | | | | |
| RPG | | 119* | | | | | | | |
| Racer | | | | | | | | | |
| Rhythm/dance | | | | | +.198** | | +.126* | | |
| Shoot 'em up | | | | | | | 135** | | |
| Sims | | 118* | | 100* | 105* | | | | |
| Sports | | +.114* | | | | | | | |
| Strategy | | +.141** | | | | +.150** | | | |

** P < 0.01 * P < 0.05

Results of the Survey



Game mechanic: "the action invoked by an agent (player or AI agent) to interact with the game world, as constrained by the game rules"

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~ (Sicart, 2008) ~

Core mechanic: "the set of activities that the player will undertake <u>more frequently</u> during the game experience, and which are <u>indispensable</u> to win the game"

Satellite mechanic: "special kinds of mechanics, aimed at enhancing already existing

activities"

~ (Fabricatore, 2007) ~



Game Mechanics !

MI and Game Mechanics

| Mechani Achievements Di Bonuses Po | ubious | rld Of rcraft | /eight |
|--|----------|------------------|----------|
| Bonuses Po | 401045 | | 5 |
| | ositive | Wo Wa | Total |
| Discovery Po | ositive | c ⁺² | <u>4</u> |
| Epic mean Infinite Gameplay Ne | Negative | | |
| Infinite gam Epic Meaning | ubious | +1 S | <u>5</u> |
| Motior Levels Po | Positive | | |
| Loss aversion Po | ositive | | |
| Points D | ubious | | |
| Reward Schedules Po | ositive | | |
| | | | |

Do These Mappings Work?

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Validated in Two Cases



Sajjadi, et al., "Exploring the Relation Between Game Experience and Game Mechanics for Bodily-Kinesthetic Players" **GALA2016**

Sajjadi, et al., "On the Impact of the Dominant Intelligences of Players on Learning Outcome and Game Experience in Educational Games: The TrueBiters Case" **GALA2016**

| | 20056 |
|--|-------|
|--|-------|

| Mechanic | Bodily-kinesthetic dimension |
|-----------------------------------|---------------------------------|
| Motion Colle | ✓ Positive |
| Timing | ✓ Positive |
| Pavlovian interaction | ✓ Positive |
| Tutorial / first run scenarios | ✓ Dubious |
| Gravity | ✓ Dubious |
| Directed exploration | - |
| Controlling Cove | - |

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Hypothesis: People with high bodily-kinesthetic intelligence will have a better game experience compare to non-bodily-kinesthetic people

22 participants - Multiple Intelligences Profiling Questionnaire (MIPQ) (Tirri & Nokelainen, 2011)

11 players were bodily-kinesthetically intelligent



11 had other intelligences

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- Three training levels
- Three medium difficulty levels
- Three high difficulty levels
- Game Experience Questionnaire (GEQ) (IJsselsteijn et al., 2008) core, in-game, and post-game modules

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Core module

In-game module



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LeapBalancer has caused its indented audience to experience significantly more competence, less negative affect, more immersion, and less tension compared to the rest of the population



Individualization (player-centered game design) based on some of the proposed mappings between MI dimensions and game mechanics seem to positively affect the game experience of

players





Validation: TrueBiters case

| Р | Q | $\neg P$ | $P \wedge Q$ | $P \lor Q$ | $P \Rightarrow Q$ | $P \Leftrightarrow Q$ |
|-------|-------|----------|--------------|------------|-------------------|-----------------------|
| False | False | True | False | False | True | True |
| False | True | True | False | True | True | False |
| True | False | False | False | True | False | False |
| True | True | False | True | True | True | True |





Validation: TrueBiters case

- **Hypothesis 1:** The logically-mathematically intelligent players would have a higher learning outcome after playing TrueBiters compared to the rest
- **Hypothesis 2:** The logically-mathematically intelligent players would have a better game experience playing TrueBiters compared to the rest

| Mechanic | Logical-mathematical Intelligence |
|------------------------------|--------------------------------------|
| Motion | - |
| Repeat Pattern | ✓ dubious |
| Memorizing Colle | - |
| Submitting | - |
| Points | ✓ positive |
| Quick feedback | ✓ positive |
| Modifier | ✓ positive |
| Disincentives | ✓ negative |
| Companion gaming | ✓ positive |
| Tutorial/first run scenarios | ✓ positive |
| Logical thinking 🖉 | ✓ positive |
| Strategizing | ✓ positive |
| Browsing | ✓ negative |
| Choosing | ✓ negative |

Validation: TrueBiters case Pilot Study on Learning Outcome

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4 participants - Multiple Intelligences Profiling Questionnaire (MIPQ) (Tirri & Nokelainen, 2011)

1 had other intelligences

3 players were logically-mathematically intelligent



- Pre-test
- Self-training
- Game sessions

| Session Number | Matches | | |
|----------------|-----------------------|-----------------------|--|
| Session 1 | player1 VS. player2 | Player 3 VS. Player4 | |
| Session 2 | Player 1 VS. Player 3 | Player 2 VS. Player 4 | |
| Session 3 | Player 1 VS. Player 4 | Player 2 VS. Player 3 | |

- Post-test
- Game Experience Questionnaire (GEQ) (IJsselsteijn et al., 2008) core module

Validation: TrueBiters case Pilot Study on Learning Outcome



Validation: TrueBiters case Study on Game Experience

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11 participants - Multiple Intelligences Profiling Questionnaire (MIPQ) (Tirri & Nokelainen, 2011)

9 players were logically-mathematically intelligent
2 had other intelligences **Self-training**Game session (2 games)

Game Experience Questionnaire (GEQ) (IJsselsteijn et al., 2008) core module

Validation: TrueBiters case Study on Game Experience

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Core module

Validation: TrueBiters case

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TrueBiters has caused its indented audience to exhibit higher learning outcome and experience significantly more immersion compared to the rest of the population



Individualization (player-centered game design) based on some of the proposed mappings between MI dimensions and game mechanics seem to positively affect the learning outcome and game experience of players based on the results of the pilot study performed

Tool Support

| | Transform Cascading Infe tubria | The internersonal dimension of the theory of Multiple Inter | ullivances that includes the following statements: | |
|---------------------------------|---------------------------------------|---|--|--|
| | Mechanic(s) | Logical-mathematical Intelligence | Kinesthetic Intelligence | 1 |
| Archen Hage | Tutorial / first run scenarios | positive | dubious | Helping |
| Questions and | Aiming and shooting | positive | negative | Repeat Pattern Spinning Plates Achievements Action Points |
| Capture Role pla. | Logical Thinking | positive | | Ownership Showing off Chain Schedules Companion Gaming Fixed Ratio Reward Schedule |
| Attacking | Bonuses | positive | positive | Fun Once, Fun Always Pavlovian Interactions Points Protégé Effect Rewards |
| Building Pattern Recognition | Levels | positive | negative | Status Identity Leaderboards Micro Leader-boards Teamwork |
| Motion Dol-eating | Quick feedback | positive | dubious | Gravity Discovery Collecting Levels Progression Dynamic |
| Timing | Spinning Plates | dubious | dubious | Quick feedback Logs Observation Aiming and shooting Information seeking |
| Meta Game | Action Points | dubious | | Realism Rich Music Epic Masing Loss Aversion Navigating on the playing field |
| | Fixed Ratio Reward Schedule | dubious | dubious | Undirected Exploration |
| L | | nide/Snow neip map | | |

Conclusions

- Empirical evidence for correlations between the different MI dimension and preferences for games
- Mappings were drawn between MI dimensions and game mechanics
- First evidence that using those **mappings** in the process of **player-centered game**

design positively affect both game experience and learning outcome

• Support tool that visualizes and facilitates the use of these mappings



Limitations & Future Work

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Limitations:



From player-centred game design to personalization and adaptation

Summary of the Dissertation

- Overview of the state of the art in individualization (player-centered, personalization, and adaptation) of learning games (<u>chapter 2</u>)
- A review of the most frequently studied aspects of a player used to drive the individualization process (<u>chapter 2</u>)
- A comprehensive conceptual framework for dealing with individualization of learning games (chapter 3)
- Empirical evidence for the existence of correlations between MI intelligences and preferences for certain games. (<u>chapter 4</u>)
- Mappings between MI dimensions and game mechanics (<u>chapter 5</u>)
- Partial validation of the proposed mappings by means two games focusing on: bodilykinesthetically intelligent players in the game LeapBalancer (<u>chapter 6</u>) and logicallymathematically intelligent players in the game TrueBiters (<u>chapter 7</u>)
- A support tool for researchers, game designer and game developers which facilitates the use of the proposed mappings(<u>chapter 8</u>)