

Serious NetGames?

Evaluating the potential of network technologies for serious games and learning assessment

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(with special thanks to Anissa Aïll & Elena Núñez Castellar)

Gaming@iMinds-MICT-UGent



- 7 researchers
- Interdisciplinary: communication scholars & psychologists
- Research into
 - Game experience, motivational factors
 - Game usage, types of gamers, use context
 - "Serious gaming": learning, training, empowerment, health...
- www.mict.be/gaming

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This presentation

- Lessons learned from five years of (user) research into serious games (SG)
- Opportunities & pitfalls for network technologies in SG area
- Structure:
 1. Background (facts & figures)
 2. Effectiveness: desired outcomes
 - a) Efficiency outcomes
 - b) Learning outcomes
 - c) Motivational outcomes
 3. Roundup

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Entertainment games: facts & figures

- Global revenue (2015): \$85-91bn
- Software (US, 2014): \$15.4bn (cinema \$10.3bn, rental \$17.8bn, music \$6.91bn)
 - Casual/mobile games ↗ (some years >50%)
 - Console games ↘
- 30-40% western public plays games
 - 95% of 12-year olds
 - 80% of teenagers
- Female players 47% (different preferences, habits)
- Average age ↗
- Young men: \$\$\$

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Serious games: facts & figures

- Hard to come by
- iDate Report (2012):
 - 2010 serious game market: \$1.5bn
 - \$6bn by 2016
- Vertical Market Report (2015)
 - 2015 global market: \$2.6bn
 - North American share 54%
 - 2015-2020: +16% per year
 - \$5.45bn by 2020

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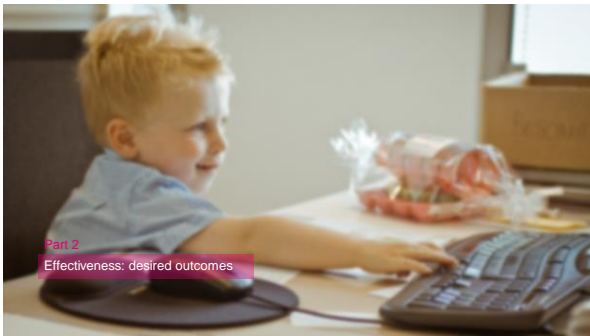
Serious subsectors

Defense	Large market, e.g. US Army recruitment game: \$50m 2010-2015
Communication	Advergaming, political communication
Corporate training	Strong growth, promising sector
Education	Traditional market yet low budgets, fragmentation of requirements formal education
Health & wellness	Strong growth, hinges on acceptance of health insurance
Activism	Games for change, vocal following & media attention, less budget
Culture	Including tourism, e.g. location-based city games, museums etc.



A different (serious) game

- Different business model, largely work for hire
- Public sector! (defense, education, health)
- Need for multiple types of expertise
- Collaborative projects: government, researchers, stakeholders, game developer
- Entertainment game developers regularly crossover (reduce risk, diversify, compensate intermediary periods)
- Competition between educational publishers, advertising, e-learning & game development companies



Serious games research @MICT

- Understand user aspects of serious game development, adoption, use and outcomes
- End users but also commissioning party, intermediary stakeholders, e.g. government, schools, training companies
- What are their requirements? What makes SG effective for them?

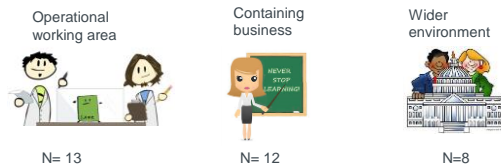


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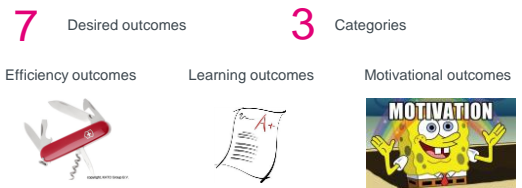


User requirements analysis

Research question: when are SG considered effective by users?
Method: three focus groups with different stakeholders



Results

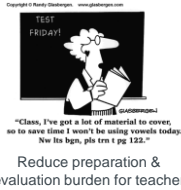


Efficiency outcomes	Learning outcomes	Motivational outcomes
Cost-effectiveness Implementation cost • Development/maintenance • Deployment in relation to a) Number of learners reached b) Total time spent by learners c) Learning outcomes d) Motivational outcomes	1. Topical interest Ability to increase interest in the learning topic. 2. Performance Ability to increase performance in chosen skillset and/or area of knowledge 3. Transfer Ability to apply learned skills/knowledge to real world situations.	1. Positive experience Ability to motivate by generating an enjoyable experience 2. Continuation desire Ability to generate interest in further learning using SG



Outcome: time management

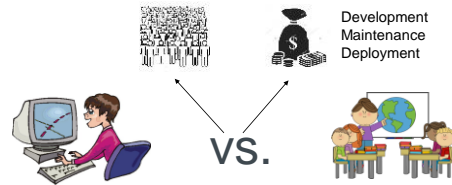
School context



Corporate context



Outcome: cost-effectiveness



Opportunities for serious netgames?

- Centralised maintenance
- Easy updates
- Ease-of-use,
- No specialised software needed
- Relative platform independence
- Control over access,
- Integration with existing systems



Outcome: topical interest

- Interest in the subject matter
- Indicators:
 - Willingness to know more about the subject
 - Motivation to know more about the subject
- Not sufficient outcome for commercial serious games!
- Not brought forward in wider environment



Outcome: performance

- Attainment of defined learning goals
- Clear MEASURABLE formulation of learning goals, e.g. *'rehearsing fractions learned in the second grade'*
- Disagreement on required 'scholarliness' of assessment *'we don't test in a scientific way, we don't have this ambition'* (e-learning company)
- Comparison of goals compared to 'traditional method' *'won't invest in a training program to serve as a control group'* (training manager)



Outcome: transfer

- Corporate and health context
- Considered a higher order learning effect
- Difficult to assess

'Afterwards, there are two ways of assessing what they have learned. The 'soft way', rehearsing, sending them a questionnaire, actively asking for feedback: is it going better now? Is it working this way? Afterwards, we actually observe: is everything happening like we want it to? A sort of 'inspection'.'
(Training manager of a company)



SoTA learning effectiveness?

Heterogeneity in study designs	Suboptimal study designs	Replication issues
- Different ways of data collection	- Confounding effects	- Implementation intervention(s)
- Different outcome measures	- Unpiloted tests developed by researchers	- Sampling
- Different statistical techniques		- Similarity interventions
		- Tests implemented

⇒ Lack of sound empirical evidence!
⇒ Need for more **systematic approach**



Better practices?

- 13 semi-structured expert interviews:



- Skype (10) and face-to-face (3)
- Structured according to five dimensions: (1) Research design (2) Participants (3) Intervention (4) Outcome measures (5) Data analysis

All, A., Núñez Castellán, E., Van Looy, J., (2016). Assessing the effectiveness of digital game-based learning: best practices. Computers & Education 92-93, 90-103.



Reduce the risk of confounding elements during the implementation of the intervention

Game as intervention vs. game as **part of** an intervention?

Do not add elements that relate to the learning content treated in the game
Reduce the amount of support provided by instructors present during game play

Effectiveness claims can only be made on the intervention as a whole



Include an educational activity in the control group

- To justify investment
- Comparison of motivational aspects
- Random assignment to conditions
 - => If not possible, matching on previous knowledge, ability, gender, computer ability and game experience
- Assure comparability between conditions (see table)

Aspect of intervention where comparability should be assured
Time exposed
Content
Instructor
Support received
Difficulty level
Interaction with other people
Day of the week
Environment
Types of exercises
Awareness of testing moment
Reward for participation



Include measures of prior knowledge

- Check for pre-existing differences between conditions
- Determine progress
- Control for characteristics of drop-outs (e.g., low achievers)



Control for individual differences

Control for individual differences

- Define mediating factors
- Define for whom serious game is beneficial
- Suggestions:
 - levels of ability
 - computer skills
 - game-experience



Include a follow-up study

- Include a follow-up study
- Check for positive findings as a result of
 - Novelty effect
 - Higher intensity training



Analyze the interaction between progress and condition

- Repeated measures
- Control for pre-existing differences
- Report on statistical significance and effect size



Opportunities for serious netgames?

- Collaborative learning
- Log & mine player behavior
 - Study learning paths
 - Develop predictive models
 - Develop learner profiles
- Create adaptive content based on learner profiles
- Automated assessment of learning





Outcome: positive game experience

- Game as entertainment medium
- Primary goal of game developers
- Secondary for schools, companies, etc.

'It just has to be fun for the target group and hopefully, they will learn something. But if you are focusing too much on what they have to learn and achieve, then it won't work' (Game developer)

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Outcome: continuation desire

- Motivation to continue learning using serious games
- Containing business & wider environment
- Decisive factor for implementation serious games



Measuring (quality of) game experience

- 2008 - now
- Multi-method: self-report, behavior, physio (heart rate, skin conductance, electromyography, electroencephalography)
- A complex undertaking
 - Diversity in games
 - (Material) inconsistency of single game between playing sessions
 - Multiplicity & simultaneity of stimuli
 - Fluidity of QoGE dimensions
 - Temporality of QoGE

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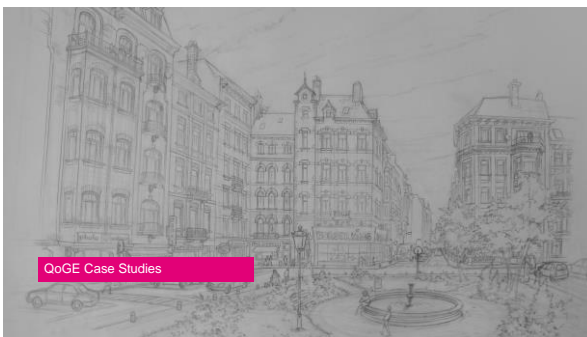
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SEGa: Self-Experience in Games



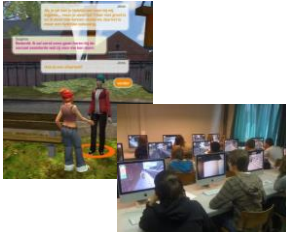
- Development of Identification Scale
 - Avatar Identification (3 factors)
 - Group Identification
 - Game Identification
- Validated for World of Warcraft, but what with other games?
- Reliable factor structure yet general correlation between experience variables

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PING (www.povertyisnotagame.com)

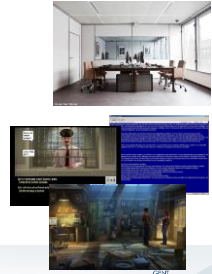


- Game against poverty and social exclusion
- Alpha, beta, RC tested with >200 pupils + quasi experiment at launch N>700
- Correlations: enjoyment – identification – perceived learning – civic engagement
- Yet use GEQ problematic, unreliable factor structure, doubtful validity
- General correlation between dimensions (method variance?)



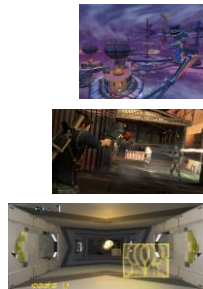
Llingo: language learning

- Link game experience - language learning effects
- Three games: two educational, one entertainment
- Strong relation experience - perceived learning
- GEQ unstable
- Games differ on multiple dimensions



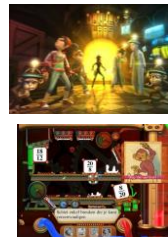
3DTV 2.0

- Study of effects stereoscopic 3D on QoGE with three games (N^{total} > 150)
 - Remastered non-S3D (Sly)
 - Special purpose S3D (Uncharted)
 - Functional S3D (prototype 3D PONG)
- Consistent effect on visual discomfort, tiny effect on experience (in within subjects design), no interaction
- Questionable comparability of playing sessions in between subject designs due to limited playing time, material inconsistency stimulus material



Games@School (G@S)

- Learning effect commercial math learning game Monkey Tales > paper exercises (in press Information Sciences)
- Retrospective self-report QoGE measures, what with development over time?
 - logs tell part of the story
- Smileyometer for measuring children's enjoyment highly skewed distribution
 - looking into relative enjoyment measures
- Strong social desirability effect



Gendered play

- Effect of (perceived) opponent gender on experience of female players (within subjects experiment with AI)
- No observable effect on objective performance
- Higher stress and lower estimation own skill with male opponent
- Yet limited sensitivity of game as performance measure
- Simple casual 3D PONG game to control consistency
- (Need for physiological measures)

R U rely a girl? OMFG u can't be u must be a fag!!!! so u rely are a girl. wow. R U hot??? do u have a pic is hot so d... u single? u no for a g... suk at this its nice 2 see... who doesnt suk so liik want 2... cca??? i bet u R so hot u sou... cant beleve UR



Motives for play

- Development and validation of Digital Gaming Motivation Scale (DGMS) in seven empirical studies (in press)
- Ten motivational dimensions (expected outcomes & habit)
- Yet question of abstraction level: one game? One game genre? All games?
- Concept of game repertoires: the variety of games a player is exposed to



Conceptual Framework

Five challenges QoGE currently faces:

1. Diversity in games
2. (Material) inconsistency of single game between playing sessions
3. Multiplicity & simultaneity of stimuli
4. Fluidity of QoGE dimensions
5. Temporality of QoGE

Challenge 1: Diversity

... in types of games, play, previous experience of players

- Content: sports, puzzle, war, building, strategy...
- Device: mobile, PC, console, VR...
- Context: single/ multi-player, online/co-located/location-based...
- Difficult to match players in experimental research



Challenge 2: Inconsistency

... of single game as stimulus material between playing sessions

- Player choices
- Random factors (emergent nature)



Challenge 3: Multiplicity & Simultaneity

... of stimuli and responses

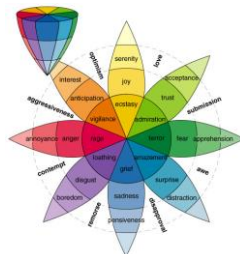
- Event-level: many things happening at the same time
- Multi-modal representation, e.g. visuals, sound, haptics
- Interaction, multi-tasking



Challenge 4: Fluidity

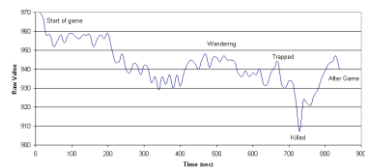
... of QoGE dimensions

- Continuous & multi-levelled (lack of clear boundaries)
- Interrelated (strongly correlational)
- Individual (subject to interpretation, danger of method variance)



Challenge 5: Temporality

... of emotional involvement in course of playing session



Solution?

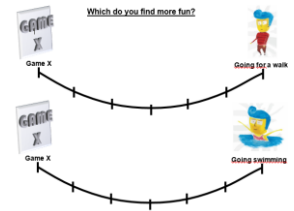
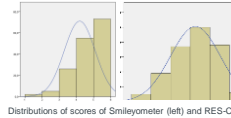
Address complexity, some potential solutions:

1. Diversity: careful study, no one for all solution
2. Inconsistency: descend below playing session as base unit
3. Multiplicity & simultaneity: use custom games to isolate specific determinants of QoGE
4. Fluidity: develop more systematic mapping of research questions, relevant emotional responses, measurement instruments, combine subjective with objective measures
5. Temporality: develop instruments for studying QoGE over time: in game behavior? Facial expression? Physio? Periodic sampling?



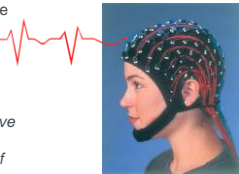
Relative experience measurement

- Measure experience relative to other experiences
- Higher validity, reliability, sensitivity than traditional self-report measures



Electroencephalography & Flow

- Flow: skill/challenge balance
- Heightened motivation, lost sense of time
- Behavioral: reaction times to secondary task (oddball paradigm)
- Electroencephalography: frontal cortex, attention networks

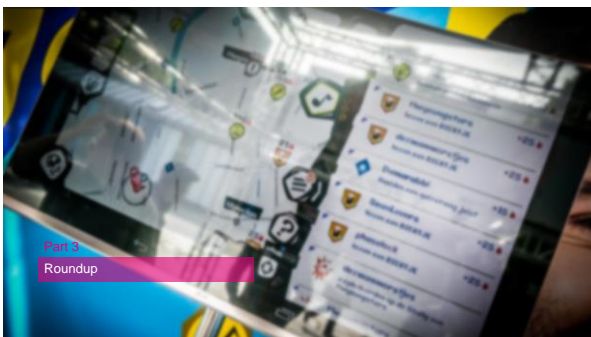


Response-locked fronto-central negative deflection significantly delayed during flow, likely signaling the re-allocation of attentional resources



Opportunities for serious netgames?

- Multi-player cooperative serious games
- Log player behavior
 - Develop behavioral measures of QoGE
 - Study experience over time
 - Predict dropout
- Develop dynamic models of QoGE based on user data
- Create adaptive content



Roundup

- Serious games: fast-growing market
- Required outcomes for SG to be effective in comparison to business as usual
 1. Efficiency
 2. Learning
 3. Motivation
- All three present specific challenges to researchers: conceptual & methodological
- Strong potential contribution of internet-based gaming platforms in modelling learning, game experience





References:

All, A., Núñez Castellar, E. P., & Van Looy, J. (2015). Towards a conceptual framework for assessing the effectiveness of digital game-based learning. *Computers & Education, 88*, 29–37.

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Questions?

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