TALLINN UNIVERSITY

School of Digital Technologies

Digital Learning Games

The impact of engaging game mechanics on learning experience: a study of educational game about XX century art.

Kaashaarvate mängude mehaanika mõju õppimisele XX sajandi kunstist rääkiva arendava mängu näitel

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Tallinn 2018

Declaration

I hereby declare that I have written this thesis by myself and without support from any other person or source, and that I have only used the materials and sources indicated in the list of work cited. Neither I myself nor any other person has submitted this to any other institution for a degree or for publication.

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Abstract

The objective of this research is to study integration of game mechanics and learning content as well as the instruments that help this integration. The game about XX century art was designed to support learning and engage player into game experience at the same time. Later the game was developed in a form of a prototype. To test engagement and learning aspects of prototype focus group was gathered. The group playtested the prototype and had immediate group interview. The results indicate that deep integration of game mechanics and learning content invokes curiosity in educational topic. The results also touch on an importance of game feedback, clear rules and UX quality of the prototype.

Keywords: educational games, game mechanics, learning mechanics, core loop, motivation, feedback, playtest, focus group, XX century art, art.

Summary

Concept of games as educational tools have got a high popularity nowadays. When games are applied to learning they promise an intrinsically motivating experience and high educational outcomes. A number of successful educational games prove the potential which games provide for education. Although a vast majority of current examples of educational games focus mostly on educational content and nearly ignore development of game mechanics. What's even more important educational games ignore the integration between game and learning mechanics. These games are highly loaded with educational content and provide minimum gaming experience. In turn this results in experience which is not engaging as games usually are.

The aim of this research was to study game mechanics as a ways of engaging into learning content. The mixture of qualitative approaches were used in order to study the topic. The literature review gathered an overview over current educational games theories. This knowledge was applied to design a game about XX century art. Later the game was playtested in a focus group of 4 people.

There are two major findings of this research. First is that deep integration of game and learning mechanics creates engaging experience. The prototype game was reported to give an interesting perspective on art in general and players report higher engagement into gameplay then merely going to a museum. Second major finding is that the prototype game should clearly indicate all the rules (even minor) to the player. In case of this research the game had a number of implicit rules which were not presented to player which turned into ruined game experience. Players spend a lot of time and energy on an understanding of the hidden rules which in turn drove players away from learning content - paintings.

The results of this study can be reused for a variety of situations. Any educational game should have a high focus on game mechanics as a tool to provide engagement into an educational content. This study also indicates that clear game feedback and can be reused for the design of UI, UX or game experience to provide a clear connection between game rules and a player.

Kokkuvõte

Mängude kui haridusvahendite kontseptsioon on tänapäeval populaarne. Mängud lubavad õppimisele sisuliselt motiveerivat kogemust ja õpitulemusi. Mitmed edukad harivamängud tõestavad potentsiaali, mida mängud haridusele pakuvad. Kuigi enamus haridusmängude praegustest näidetest keskenduvad peamiselt hariduslikule sisule ja peaaegu ignoreerivad mängu mehaanika arengut. Mis veel tähtsamad haridusmängud ignoreerivad mängu ja õpetaja mehaanika vahelist lõimumist. Need mängud on väga koormatud hariduslikust sisuga ja tagavad minimaalse mängukogemuse. See omakorda toob kaasa kogemusi, mis ei ole seotud mängudega, mis tavaliselt on.

Uuringu eesmärk oli uurida mängu mehaanikat õppevormina osalemise viise. Selle teema uurimiseks kasutati kvalitatiivsete lähenemisviiside segu. Kirjanduse ülevaate mäng ülevaade praegustest haridusmängude teooriatest, neid teadmisi rakendati XX sajandi kunsti mängude kujundamisel. Hiljem mängiti mängu 4-liikmelises fookusgrupis.

Selle uuringu kohta on kaks peamist tulemust. Esiteks on see, et mängude ja õpimehhanismide tihe integratsioon loob rohkem huvitavaid kogemusi. Prototüüpide mäng oli üldiselt huvitav ülevaade kunsti kohta ja mängijad teatasid kõrgemast haaratusest mängus, vaid lihtsalt muuseumisse minekuks. Teine oluline järeldus on, et prototüübi mäng peaks selgelt näitama kõiki mängija eeskirju (isegi alaealisi). Selle uurimuse korral oli mängul mitmed kaudsed reeglid, mida mängijale ei esitatud, mis muutus mängukonkurentsiks. Mängijad kulutavad palju aega ja energiat varjatud reeglite mõistmise eest, mis tõid nad mängust välja - maalid.

Selle uuringu tulemusi saab kasutada erinevatel olukordadel. Igasugune haridusmäng peaks keskenduma mänguautomaatidele kui vahendile haridusalase sisuga kaasamiseks. See uuring näitab ka selget mängu tagasisidet ja seda saab uuesti kasutada UI, UX või mängukogemuse kujundamiseks, et tagada selge seos mängureeglite ja mängija vahel.

Introduction

Computer games are fantastic: they are motivating and rewarding, people are ready to invest huge amount of time playing them. Most of us can find a game for themselves: pick a gun and shoot enemies in *Battlefield*, build empires and colonies in *XCom*, watch a movie-like story of love, hate and devotion in *The Last of Us*; watch how abstractions can build strong emotions in Journey; ride a fantastic sports car in *Gran Turismo*. You can even feel yourself in the shoes of a mentally ill-person and get how painful it is not to listen to the voices in your head in *Hellblade: Senua's Sacrifice*. If you want a smaller experience you can pick your phone launch *Candy Crush* and smash colorful candies, solve mind-blowing spacial puzzles in *Monument Valley*, have a quick golf tournament with you friend in *Golf Clash*. The point is: games are a beautiful and powerful medium for any type of message you want to tell, for any type of experience you want to provide.

What makes games stand out from other media sources is a powerful and complex toolset: audio systems to play music, dialogs and sound effects; visual systems to paint worlds and characters; input systems to provide player's interaction and multiplayer systems to socialize and play with friends. Movies, for example, utilize only audio and video systems but provide deep and purposeful products.

One of the most important components of any game is learning, and commercial games use it heavily. For instance, *XCom 2* is a stand-out example of incorporating tactical and strategic learning into a commercial game. The game teaches a complexity of positioning forces at the battlefield and importance of role-based team work. It implicitly teaches how important the notion of a team is: one strong unit will lose against 3 middle units, though the upgrade costs the same in both cases. On another layer the player can learn strategic thinking: losing best soldiers at the battlefield will harm player's overall progress, because novice soldiers die way faster in later game. The game learning mechanism is punishing: the difficulty curve is high and even experienced players suffer from losing. Players need to repeat the same mission multiple times to finish it.

That's why games seem to be perfect match for education. Games can emulate complex systems and give an easy control over them, while providing a depth to mastering skills. The power of games to influence players' life after the game session has been studied by many scholars and most notably Ian Bogost. He argues that games can be used as a persuasive medium to influence the behaviour of the player and potentially even change person's behavior in the long run (Bogost, 2007).

However, most of the educational games don't fulfil their promise of being fun and educational at the same time (Ritterfeld at al, 2009). A typical pitfall of educational games is trivia genre: present a learning content in any convenient way, ask questions and evaluate the answers. This is a traditional classroom teaching method which makes no use of unique power of games: gamified mechanics, rewarding challenges and simulation of complex systems.

Popular examples of educational games invent new game mechanics to match specific educational content. *September 12th* addresses the problem of terrorism in a very straightforward way. There are terrorists in town, player can shoot them. When the terrorist is dead their relatives mourn for the loss and become terrorists to pay a revenge. Which makes the message of the game very clear: the more you kill terrorists the more terrorists are there. This example stands out because the message is expressed by the means of game mechanics and provides a depth to understanding why the killing is bad, rather than simply stating that.

Proper combinations of games and pedagogy produce games that make learning relevant and meaningful(Foster, 2008). However low number of successful examples of educational games is what drives this research. Game mechanics provide broad opportunities to engage people into the learning content. But available examples of educational games rarely use games mechanics for that purposes. Still future research into combinations of game design and content is needed(Foster, 2008). The aim of this research is to addresses exactly the usage of game mechanics for learning content.

Research hypothesis and goals

The aim of this research is to study game mechanics as a tool of engaging into educational content. As stated previously, modern educational games integrate learning content into game mechanics, which provides ultimately fun and deep learning experience. Which leads us to theoretical part and research hypothesis.

Research hypothesis: "A harmonious integration between game mechanics and learning content can make learning games more effective". This statement is very general and addressing it only from theoretical point of view may not be quite correct. Games are tangible products and the statements that concern them needs to be proven in a practical way as well. Which leads us to the second structural part of this research:

Research example: to address the hypothesis in a practical way, an educational game which supports the hypothesis is created and tested. Educational topic is fixed to XX century art history which is an interesting and broad topic to study. This period features vision changing movements, such as cubism or fauvism, depicting the world in unusual shapes or colors. The paintings invoke a broad range of emotions in viewer's eyes. All of this makes this topic useful for a wide audience.

Completion of following atomic goals is required in order to address both theoretical and practical parts of the research:

- *Goal #1*: Determine the methods to enhance learning in educational games.
- Goal #2: Study entertaining game mechanics' influence on learning experience.
- Goal #3: Determine possible game mechanics suitable for educational game of XX century Art history.
- Goal #4: Design and implement a prototype of educational game of XX century art history.
- Goal #5: Test a prototype on a group of participants.
- Goal #6: Make a conclusion of correctness of research hypothesis based on test results.

Research methodology

To address the research goals and closely study research hypothesis a number of research methods were combined forming a mixed method research. The following plan illustrates step-by-step research process:

1. Literature review
2. Design of a game about XX century art history
3. Prototype of the design
4. Playtest the prototype
5. Semi-structured pilot interview
6. Focus group interview
7. Data evaluation

Literature review comes in the first place to gain in-depth understanding of topic and state of art of educational games. Moreover, literature review reveals existing studies on the topic and their findings. Effective review creates a proper foundation of the knowledge and influences heavily next stages of the research (Webster & Watson, 2002). Thus, literature review is used to study first and second goals of the study.

To address the hypothesis of harmonious of game and learning mechanics, an educational game was set to be designed, prototyped and tested. The design of the game would focus on the first part of the hypothesis: proper combination of game mechanics & learning mechanics, which is a first challenge of this research. Designing the game to be fun is common challenge for game designers. However, considering the large number of successful commercial games and humble number of successful educational games - designing the game to be fun and educational at the same time is of higher challenge. In this case the design of an educational game matches third goal and pushes research process to the next stage.

Prototype comes when the game design is ready to be tested. A prototype is a learning tool which provides precise ideas of what the target game would be (Floyd, 1984). A prototype helps to evaluate core mechanics of the game and if game idea "works". Plus this method helps to find fundamental design problems early in

development and could prevent huge production and time investments into development of the ideas which will be found problematic in the future and will be removed from the game later on. In case of this research, the prototype was used to address goal #4: to practically implement the design of the game from previous stage. A tangible game makes playtesting with target audience possible and what's even more important, it enables collection of feedback of target audience.

Finally, two methods were used to collect player's feedback on the prototype game and address goals #5 and 6. Both qualitative methods were used to support the the conditions of the prototype:

1. Nature of prototype implies unfinished or underdeveloped game parts. In this case the assistances of researcher is needed to explain participants what's the game capable of and what not.
2. Purposefully underdeveloped ideas in game enable participants to make suggestions. It's worth considering what the actual players of the game want and what are their vision on the same subject. The designer can lose a connection with player audience easily because of constantly working with the same ideas.

Semi-structured interview was used for the pilot study. According to Brinkmann, researcher provides basic structure of the interview and ambiguous questions based on their research interests but allows room for the respondent's more spontaneous descriptions and narratives (Brinkmann, 2014). In this way the participant's responses can reveal more in-depth understanding of the topic.

Focus group interview was selected as a final testing method. Focus groups enable the collection of diverse ideas & thoughts on the topic, and interaction between participants can lead to in-depth understanding of their way of view on the subject. Participants may push the ideas which resonate with other participants and create a proper in-depth discussion.

While conducting both pilot interview and focus group interview full audio dialog was recorded for future analysis. Later the audio recording was transcribed and analysed which formed the results of this research.

Theoretical framework

Serious games

Games are thought to be a suitable medium to deliver different types of messages and entertainment is only part of it. The notion of serious games covers a broad range of applications of persuasive messages delivered through gameplay: games about healthcare or education; games that motivate change in player's behavior; skill practicing games. Serious games are believed to be in-between fun and learning: serious games can take an advantage of the engagement & fun gameplay and pack serious content inside of the game. This way the players may not even know that they are learning during the game sessions. Many scholars see serious games as being engaging, meaningful and purposeful (Ritterfeld et al., 2009). However, other game scholars doubt the combination of games and serious content. Newman pointed to oxymoronic definition of literal meaning of serious games: "games themselves are inherently fun and not serious" (Newman, 2004).

On the other hand, Ian Bogost in his work "Persuasive games" argues that videogames have a unique persuasive power. Games have a huge impact on the players and can change their beliefs. Video games can support existing social and cultural positions and beliefs, on top of that they can also change those positions, leading to potentially significant social change (Bogost, 2007). Which makes them a proper medium to convey serious messages.

Serious games are built on two main concepts: gameplay, which generates engagement and fun, and educational message which is supposed to make change in real life. The common question of serious games is what comes first: gameplay or serious message? Ritterfeld et al. answer this question clearly. "In serious games we assume that the gaming element is prevalent; that is the game is used as a toy. Using digital games as toys implies that the activity itself is intrinsically motivating because it provides fun" (Ritterfeld et al., 2009). In other words: game element is the central concept in serious games.

Although the notion of serious games looks promising in theory, many real-life examples of these games don't fulfil their promise of being fun and educational at the same time. Edutainment had the first attempts to teach academic information though games. Its main mission was to involve play elements in common class activities. Unfortunately this movement wasn't successful and extinguished quite fast. In *Serious Games: Mechanisms and Effects* authors state that up to this point there's no such a good blend between entertainment and education in a form of a game: "… Entertainment and education still appear as two distinct, separate aspects of game play that follow each other and demand that the user shift his focus from one to another" (Ritterfeld et al., 2009).

On the other hand, it's not so evident what educational impact is expected from the experience of playing the game: is it specific facts that player learned, is it practice of skills or it's a mind-changing thoughts player can have while in game world? Ritterfeld et al. argue that the educational impact isn't just skill practice or knowledge acquisition: playful activities improve problem solving skills, incidental learning is a common attribute of a gameplay and exploration. Moreover, games provide a unique interactivity opportunities: a safe space for failure and experiments. "Unique advantage of games is not so much in delivery of curricular content but providing opportunities for exploration, experimentation and problem solving" (ibid.). Games also enforce cognitive problem solving and social problem solving.

Repetition and practice are common teaching methods that have its advantages and disadvantages. Unfortunately this method is being abused by serious game developers and results in the same class activities being transferred from a notebook to a phone or a computer. Game developers seem not to use interactive and engagement components enough and produce games that are not fun to play. Ritterfeld et al. confirm this saying: "… most serious games do not go beyond this traditional role [repetition and practice] and are certainly not fulfilling the potential that serious game promise" (ibid.). Exploration and experimentation are more convenient learning methods and provide

accessible depth to understanding the material. Commercial games already take advantage in using these methods to present their story and specific game rules.

That being said, serious game developers and designers should put enough effort into making the game actually fun and engaging. Although a serious message seems to be of a higher importance, designers and teachers choose a game medium for reason. The requirement of a game medium to be playful and interactive is of the same importance as a requirement of the serious content to be educational and behaviour-changing.

Serious games topics

Backlund & Hendrix (2013) summarized available information on educational games topics, effectiveness and usages in the recent research "Educational games - Are they worth the effort? A literature survey of the effectiveness of serious games". Mathematics and language learning are the most frequent examples of serious topics which show mostly positive effect. Less frequently serious topics are higher cognitive skills such as collaboration, argumentation and problem solving, which show positive effect on the players as well. Among other topics Backlund & Hendrix distinguish behaviour change, computing, surgery and natural sciences.

Yang (2012) addressed the difference in effectiveness between a game-based learning approach and traditional learning in a full semester quasi-experiment study. The aim of the study was to compare problem solving skills, motivation and academic achievement between an experiment group (using digital game based learning) and a control group (using traditional learning). Results show that gaming experience improves problem solving skills while control group showed no improvement in the same field. On top of that, experimental group showed higher learning motivation. Finally, there was no statistically significant difference in academic achievement tests result between two groups. Based on the improvement in problem-solving and learning motivation Yang draw a conclusion that educational games may be a useful tool to support and reinforce learning process.

It's worth mentioning the attachment of players to the information they've seen or heard in the language learning games. Player pay detailed attention to text and audio in the game. Moreover, once the player memorized a word or a chunk of dialog, they are ready to adapt this information to different context (Backlund & Hendrix, 2013). During the gameplay session player develop their game vocabulary including borrowed terms and concepts. When discussing a game afterwards players often use words from their game vocabulary and often repeat exactly the same wording.

Making a game serious doesn't always require creating a game from scratch. Chappin et al. (2017) took a popular commercial game about trading The Settlers of Catan and made the add-on to teach sustainability. The add-on introduces an oil as a new resource and new rules that come with it. Oils is expandable, its usage pollutes the atmosphere and lowers other resources and extensive oil usage over a short period of time can even flood the Catan and end the game with no winner. The results of the research state that the game positively influenced people's awareness and their understanding of sustainability issues. Players collaborated on oil usage in competition game to prevent flooding. This example illustrates importance of finding a suitable mechanic for educational content and positive results it can produce.

Game mechanics

So serious games come in two pieces: gameplay and serious message. Gameplay is a structure that is based on a number of different pieces, but most notably any game is formed around rules. Any sports games starts with an activity and rules that govern it. Simple outdoor game named tag performed by children usually starts which defining the one player that's catching the others and when he got somebody it means transferring catching role to the victim. The term game comes with a lot of different definitions but most of them agree that the most essential feature a game is rules (Adams & Dormans, 2012). For example, Adams provides following definitions in his work Fundamentals of Game Design: *"A game is a type of play activity, conducted in the context of a pretended reality, in which the participants try to achieve at least one*

arbitrary, nontrivial goal by acting in accordance with rules". Rules define roles, actions and outcomes, they create basis for intractable experience.

Game mechanics is even more general concept than game rules. Adams & Dormans provide following definition of this term: *"Game mechanics are the rules, processes, and data at the heart of a game. They define how play progresses, what happens when, and what conditions determine victory or defeat"* (Adams & Dormans, 2012). Game mechanics put an extra layer on game rules: using the rules game mechanics define resources, events, player skills & abilities, power of actions, rewards, timers, etc.

The term game mechanics cover such a broad range of game components that it's impossible to get a specific context from the term on its own. That's why core mechanics is usually referred to the basis of a game: the most essential rules and roles changing one of them will make into a completely different game. Stating that the game is *first-person war shooter* provides an understanding of its core mechanics: player is going to get an arm rifle and shoot some enemies at war. Changing it to *first-person war adventure* creates a completely different game: player is still going to be at the war but now he solves puzzles and maybe doesn't even shoot anyone. While platformer adventure provides another core mechanics: player is going to run, jump and solve puzzles.

Adams & Dormans provide the following definition of core-mechanics: *"The term core mechanics is often used to indicate mechanics that are the most influential, affecting many aspects of a game and interacting with mechanics of lesser importance, such as those that control only a single game element"* (Adams & Dormans, 2012).

The nature of a game mechanic can be discrete or continuous (Adams & Dormans, 2012). Discrete mechanic operates on integers: player can pick one power-up, but not a half of it; he can build 2 barracks, but not 2.15 barracks. Continuous mechanics on the other hand rely on gradual transitions: gravity in platformer game will be increasing the speed of a falling object till it lands, the speed will be changing every

frame. The object will be falling for 0.3 seconds from 2 meters high, and 0.1 second from 0.5 meter for example.

Adams & Dormans propose a categorization of game mechanics with 5 different types:

1. Physics - define how objects move and rotate.
2. Internal economy - the game resources, such as money, experience or health; and ways these resources can be obtained, spent or exchanged.
3. Progression mechanisms - split the game world into multiple parts and control the access to them. Your character might need a golden key to open the castle door, but the key is hidden in the jaws of medium-sized dragon.
4. Tactical maneuvering - rules that define advantages or disadvantages of unit placement on the game map.
5. Social interaction - interaction with other players. Casual games encourage players to give gifts to each other; strategy games provide an advantage of forming alliances and smashing an enemy with two armies.

There a lot more to say about game mechanics or core mechanics. As well as forming the essence of the game these terms form an essence of this research paper.

Flow

Games are praised for being fun, engaging and motivating. On top of that, properly designed and executed games proudly invoke player's immersion. Immersion is being described as a person's state, when only the game matters. In this state people are being "disconnected" from the real world: they forget about their real-life position and what they do, they stop hearing sounds and noticing real-time events. It's also known to have huge educational impact because person is focused on the game and ready to receive and adopt new information. Basically, this is what serious games aim for: to put a player into a focused position and concentrate his attention on things that matters, educational content in this case.

Immersion state is a general term and can happen in any area other than a game. Back in 1990 Csikszentmihalyi introduced a theory which explains intrinsic motivation of a player. According to this theory, flow is being completely involved in an activity for its own sake. Applied to design of serious games, Paras & Bizzocchi (2005) describe flow as a "state where there becomes a perfect balance between challenge and frustration, and where the end goal becomes so clear that hindrances fall out of view". Paras & Bizzocchi argue that flow theory is a bridge between serious content of the game and its playful activities. A key property of flow is a feeling of enjoyment. According to Csikszentmihalyi (1990), enjoyment results when a person has not only achieved their programmed goals but gone beyond their bounds and achieved something new. Which means that enjoyment has a attribute of novelty and accomplishment. Csikszentmihalyi also argues that enjoyment has eight major components:

1. Tasks with a reasonable chance of completion
2. Clear goals
3. Immediate feedback
4. Deep but effortless involvement that removes from awareness the frustrations and worries of everyday life.
5. Sense of control over our actions
6. No concern for the self
7. Alteration of the concept of time, hours can pass in minutes and minutes can look like hours.
8. The autotelic quality of flow-experiences: not only the achieving of the goal is rewarding, but activity itself is fulfilling.

This theory is originally applied to everyday lives and in some way addresses the question of what happiness is and how to achieve it. It's not a surprise that it's used to describe an immersion a player feels in special moments. In these moments players feel like they mastered the game and the challenges which seemed impossible to achieve at first is at the tip of their fingers. This is exactly what educational games seek for.

State of the flow has another big advantage: the learner is completely motivated to push their skills to the limit when experiencing flow (Paras & Bizzocchi, 2005). This means that player is ready to put so much effort into learning and makes it a highly desirable for any learning activity. But player is ready to do so when they meet appropriate challenge. According to Csikszentmihalyi (1990), "A flow experience has got to be challenging. Anything that is not up to par is going to be irritating or ignored". Paras & Bizzocchi (2005) argue that motivation, challenge and a clear goal create perfect learning experience. Flow shares all of this components and creates intrinsic motivation.

To describe flow's position in the game Paras & Bizzocchi use following concept map:

Games -> Play -> Flow -> Motivation -> Learning

Authors describe it as "games foster play, which produces a state of flow, which increases motivation, which supports the learning process". The right combination of game mechanics and learning can create an intrinsically motivating experience. Thus the challenge of serious game designers is to build an environment where learning is integrated into the gameplay.

GameFlow

Concept of flow is a foundation of enjoyment of challenges in everyday's life. Great game experiences are often described in terms of flow. That's why more direct adaptation for games was done in a research "GameFlow: a model for evaluating player enjoyment in games" (Sweetser & Wyeth, 2005). Original flow concept uses abstract properties which can be applied for any field. While GameFlow describes flow in a very specific for games terms. Meeting this properties in your game could mean that the game can provide a flow experience:

1. **Clear Goals.** Why the player needs to do anything in first place.
2. **Challenge.** Getting better brings positive emotions. And that's possible only when the challenge is set in first place.
3. **Concentration -** player need to focus on the game.

4. **Player Skills.** Player need to learn new skills as well as to have enough time to practice the skills they already learned.

5. **Control.** Players must be allowed to exercise a sense of control over their actions.

6. **Feedback.** Game should support immediate feedback, which make user aware of the consequences of their actions.

7. **Immersion.** Players should experience deep but effortless involvement in a game.

8. **Social Interaction.** Games should support and create opportunities for social interaction.

This theory brings more specific approach to designing and evaluating game experience.

Motivation

Motivation is very important for any learning experience. No one can learn anything if they don't want to. Motivation pushes a learner to put an effort into learning or doing. Effort occurs only two prerequisites are met:

1. The person values assigned task
2. The person believes they can succeed at the task.

To make a learning activity motivating, the following components are needed (Paras & Bizzocchi, 2005):

1. Attention strategies - to gain an keep the interest in the activity
2. Relevance strategies - to show why activity is needed and where it can be applied
3. Confidence strategies - to develop confidence in learners actions.
4. Satisfaction strategies - to satisfy intrinsic and extrinsic goals.

Learning Environments

Game environments are an important tool for supporting enjoyable experience and enable learning. Traditional learning environment is very limited: the teacher

broadcasts information in front of the students. Game environments can provide personified interactive experience of acquiring information and reinforcing it: game can pick a personified goals for a student that matches the skill level. Houser and Deloach (1998) review Donald Norman's work: Things that make us Smart. Authors identify seven basic requirements of a learning environment:

- Provide a high intensity of interaction and feedback.
- Have specific goals and established procedures.
- Motivate.
- Provide a continual feeling of challenge that is neither so difficult as to create a sense of hopelessness and frustration, nor so easy as to produce boredom.
- Provide a sense of direct engagement, producing the feeling of directly experiencing the environment, directly working on the task.
- Provide appropriate tools that fit the user and task so well that they aid and do not distract.
- Avoid distractions and disruptions that intervene and destroy the subjective experience.

These properties of learning environment match closely to flow experience. Moreover, Houser and Deloach conclude that Norman's properties for learning environment intersect with properties of game environment which means that learning is integrally related to games. The amount of learning that needs to be done to play successfully in a game is hidden by the fun factor of the game.

Making an environment safe to fail and retry also has positive impact on motivation. Failing signals that player is not aware of how the game works and pushes them to learn prior to attempting again. Safe environments have other big advantage in experimentation: safe environments enable experimentation but only when a mistake doesn't cost anything and player is free to fail. Users are free to create hypotheses and test them, try number of approaches and pick the one that works best for the player. Supporting players failure is one of the basics of successful learning environment.

Reflection

Acquiring & processing of the new information are important parts of the learning process. Reflection is used as part of learning process to strengthen the quality of acquired information. Describing the problem and knowledge in their own words and expersessing their own thoughts positively influences understanding of the topic. It also reveals parts of the knowledge which the student strongly understands and part where the student feels weak. Moreover, while finding the answer student reflects on their knowledge and their own understanding of the topic.

The process of reflection develops idea further and shows different views on the same idea. Paras & Bizzocchi (2005) argue the reflection transforms learning process from linear to cyclic:

1. Experiencing
2. Reflecting on the experience
3. Drawing conclusions based on the reflections
4. Planning new actions based on the conclusions
5. Start again from the first step.

Without reflections it wouldn't be possible to draw conclusions and review actions and experiences. This way the development of the idea is possible until no sharp edges left and the idea is fully understood by student.

Games don't seem to be a proper medium to use reflections at first glance: games require actions, not thinking. A nice example why it's not true is strategy genre in general: in strategy games players are expected to plan their actions, calculate possible outcomes and pick up the best possible strategies to reach desired result. Following this example reflections could be used as in-game action to build plan or strategy to reach in-game goal. Learning in educational games takes place within the realm of play so any learning tools should be used in the realm of play.

Example of a good usage of reflection would be to ask ambiguous questions that don't require a correct answer. This way learner looks on the acquired knowledge from different perspective which in turn strengthen the connections between concepts.

Mapping learning & game mechanics

Arnab et al. (2014) made a theoretic tool to address relationships between game and learning mechanics in serious games. The purpose of this LG-GM model is to serve as a bridge between learning methods and game methods and enable unified design of educational games including both aspects of play and learning. Basically this model shows a pool of leaning mechanics and pool of game mechanics. Educational game designer may refer to these pools when designing a game to design simultaneously learning processes and playful activities. Moreover, this tool can be used for existing games as a reflection tool: it helps to identify game and learning mechanics in existing game, and connect them. Furthermore, designers can create a map of dynamics of mechanics during the flow of a game to show how mechanics change themselves and support each other.
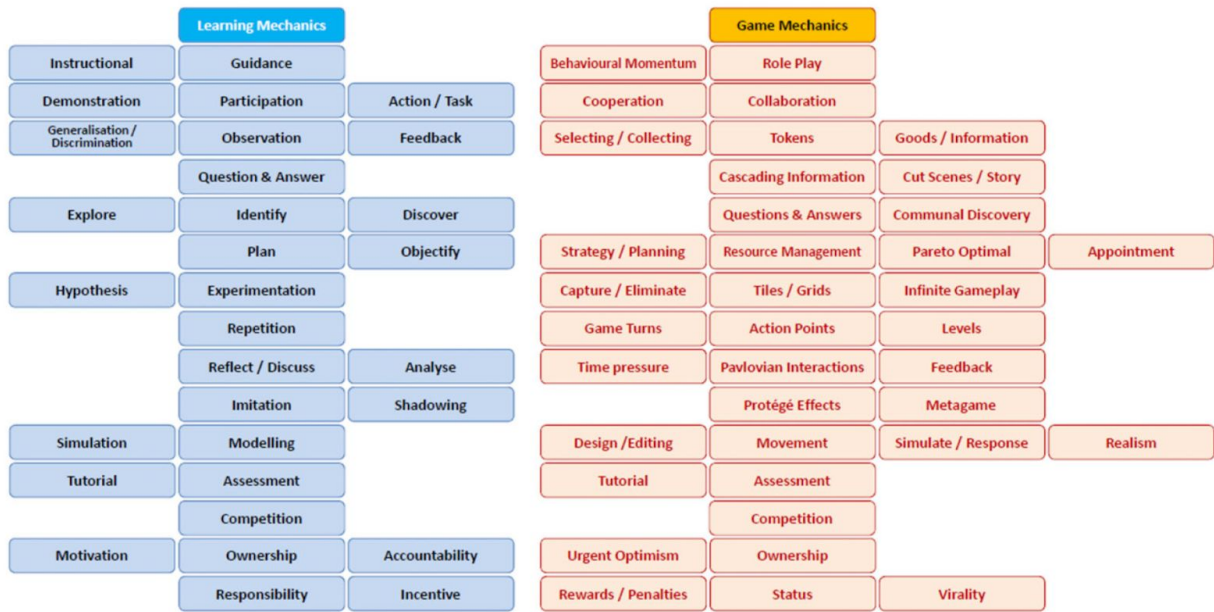
Learning mechanics-game mechanics

The model presents a broad range of existing knowledge, but unfortunately it doesn't present the relationships between two mechanic spaces or even some common usages. For example, demonstration (LM) is best known to be implemented through cut

scenes or story (GM), however same demonstration mechanic can be done using collection or design/edit game mechanic or even viral informational space in the game. Further research could be done to collect existing pairs of LM-GM and categorize proven relationships. Another questions that this model enables is whether the games should adapt to existing pedagogical practices or pedagogical practices should adapt to game activities since educational games serve as single entity that educates and entertains at the same time (Arnab et al., 2015).

Promoting learning in games

Environment plays a huge role in player's experience. Dickey's study "Murder on Grimm Isle" aim was to build a game that promotes narrative skills of the player. The game was designed in a way that it gives a player distinct pieces of the story of murder, eg. a note, a broken wine glass and player needs to finish the puzzle with its own explanation of the story. The game was done in typical 3d environment and first-person view. Initially participants were excited to even be playing educational game and they immediately looked for game-lie patterns and mechanics. Students expected clues to progress the story, but they didn't and actually there was no winning condition, no challenge and no unlocking progress. That's why students report disjuncture and drop of encouragement after the discovery that there are no game rules. This finding particularly points to the attitude of people to educational games: they immediately look for the rules and mechanics.

Mayer & Johnson (2010) addressed an importance of the feedback in the game in their study "Adding Instructional Features That Promote Learning in a Game-Like Environment". Explanative feedback means that the game explains what the player did wrong and how not to make the same mistake again. For example, if you got shot in multiplayer game because you were standing in the middle of the room without a cover and the game tells you "next time - find a cover, don't be standing open" - that's explanative feedback. Study confirms that explanative feedback promotes learning and understanding of the system and students perform better on system with explanation to their rules than on systems without feedback. Cornillie et al.'s (2012) work on an

immersive game for English pragmatics highlights corrective feedback to support the player and promote understanding of the game and its contents. Educational games should provide as much corrective and explanative feedback as possible to promote understanding, confidence and skills of the player. In turn, these values will promote understanding of educational points.

Narrative is also considered to promote understanding of games. A particular study on the importance on the narrative in the game "Game Design Narrative for Learning" (Dickey, 2006) states that narrative is providing a cognitive framework for problem solving, it establishes context for the actions and helps the player to understand his mission, reasons and consequences of their actions. Also narrative allows people to assign meaning to their experiences and invest emotionally in their actions. Another study on the narrative in learning games "Intrinsic fantasy: motivation and affect in educational games made by children" by Habgood et al. (2005) finds that while narrative helps to establish emotional context, it's not the most important educational factor. Fantasy is not the main factor in creating effective integration and that integration of the learning content and the rule-system of a game is a more significant factor. For example, playing skateboarding game to retrieve pieces of computer doesn't help understanding the nature of computers, but playing as robot who needs to find his pieces back to properly function helps.

Art games

The research base for educational games which aim to teach art history is very small. The available research is "ARTournament: A Mobile Casual Game to Explore Art History" (Froschauer et al., 2012). Game mechanics of this research are quiz and competition based: player gets information about art, then quiz follows and player's results are compared on the global leaderboard. Quiz has a description of the painting and 4 variants of paintings, player has to choose one that suits description. Each new level opens when the previous is completed. Generally speaking the results of the research indicate that learning occurred and players were interested in the game. On the other hand, other game mechanics could also match art history content and create

immersive fantasy experience. The downside of quiz is that it's not immersive, there's no learning environment and there's no fun rules. Quiz can is better used to reinforce other activities, but constantly asking questions is not fun.

That's why this work was concentrated on matching the game rules that can govern art history; the rules which would provide fun and educational experience, involve problem solving and depth to the gameplay.

Prototype 1. Grand Theft Art

Prior to conducting this research author was leading educational game project within Tallinn University. The name of the project is Grand Theft Art (referred as GTA), it was a semester long and developed in a group of 5 people. GTA is spiritual predecessor of current research: GTA introduced educational topic of XX century art and complexity of educating it. The result of GTA was a prototype game with a good production value, meaning that prototype had a sophisticated graphics, sounds and level design. Unfortunately, playtests with individual participants revealed low educational results, strong disconnection between entertaining and educational components and overall interest in graphics but not art. Thus design ideas of GTA are shown in detail and analysed in this chapter.

GTA opening scene. Main hero Vincent is set explore castle full of paintings

The game started from an educational topic of XX century art plus the idea of taking successful entertaining game mechanic and applying it for project's needs.

Entertaining mechanics

Target audience of the game was set to be students and youngsters with an age range of 15-22 yo. Which means that fantasy narrative and exploration mechanics are

resonating well with the target audience. Plus these mechanics are known to invoke curiosity and intrinsically motivate the learning of the game world.

Narrative. "One wealthy businessman bought the most famous art heritage to his private collection and hid it from public. All around the world people suffer from being ignorant. The rumor roams that there's a superhero that is willing to bring back art history to everybody and end the suffering".


Protagonist Vincent and antagonist Gorgio

Core mechanics. This is a third-person puzzle-exploration game. The player takes a role of a thief-superhero Vincent who navigates through the game and steals paintings. Each stolen painting lands into an Art Book - a book with detailed info about paintings. The location of the game is the castle of the antagonist Giorgio Bulliceli. Parts of the location are locked with a door code, which player has to find in other parts to proceed. Plus, a breadcrumbs mechanic (Adams & Dormans, 2012) was integrated in a from of collectible coins to help player navigate through the level. Breadcrumbs means collectible objects put into a pattern into a game, following this pattern player may come to a pre-desired location.

Win conditions. Each level consists of two parts: exploration and test. In the first part player is expected to find a number of paintings, read their information and build his knowledge around specific art movement. The test part contains a range of paintings one of which is from the specified art movement; others are irrelevant. Player's task to review the knowledge from exploration part and guess which test painting belongs to

specified art movement. Choosing the right painting means completing the level and proceeding to the next one, while choosing the wrong one restarts the level from beginning.
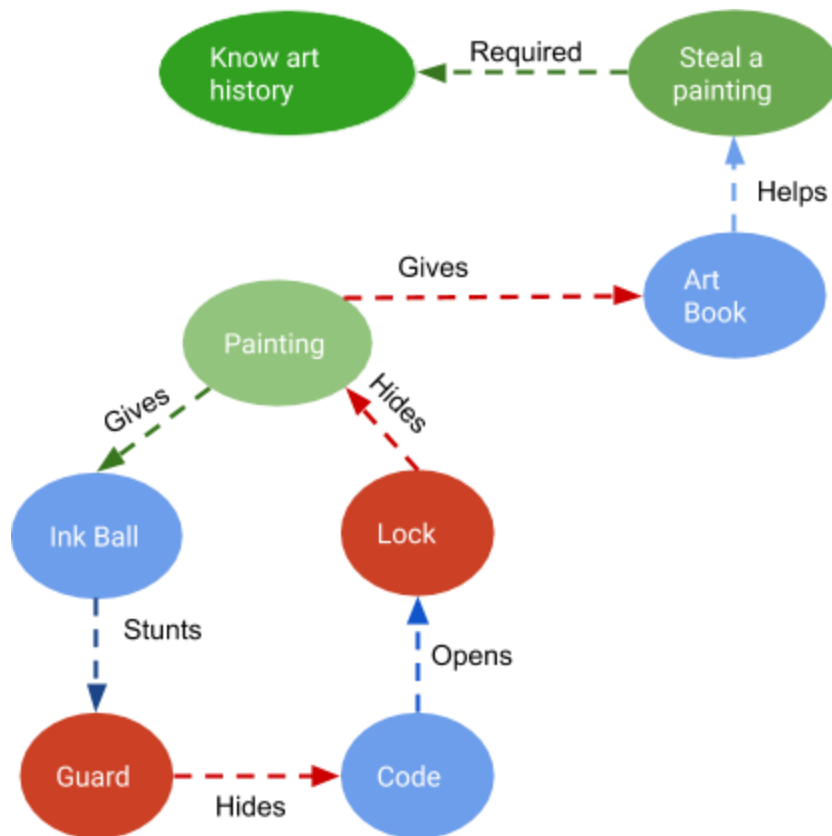

Game concept map. Guards and ink ball were expected features of the game but were suspended.

Educational mechanics

The game was set to present famous paintings from XX century, their core ideas and emotions, information about author and art movement the painting belongs to. The game was set to introduce players to art history in a friendly and appealing way: the complexity of art knowledge should be hidden by pictures and short descriptions. Invoking curiosity and further studying of art was one of desired outcomes as well. Plus each level is dedicated to one art movement to make learning structural.

Each level contains a number of paintings that player find by the means of exploration. When a painting is found it appears in an Art Book - sophisticated place to store and display information about every painting that player found.
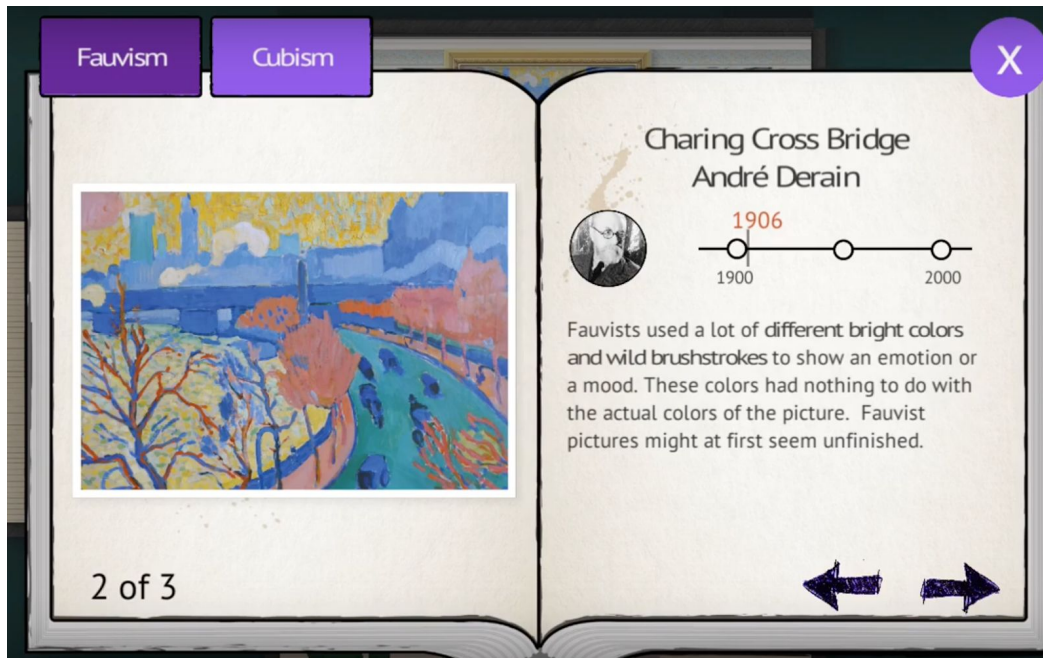
Art Book presenting one of the first paintings in the game

Which means that player merely collects and reviews the knowledge during the level. To enable reflection and review acquired knowledge player is challenged with a test at the end of each level: pick a painting which is from the same art movement.

Test room with 3 paintings to choose from.

Moreover, during the course of the round the player is guided with short notes from in-game mentor "The Bear". The tutor is there for the player not to feel lonely, plus the tutor gives good tips on what is the next player's goals and stuff.

Playtests and results

The game was ready with one playable level, which makes it 5-8 minute gameplay. Watch gameplay here: https://www.youtube.com/watch?v=BmOfS8QP8A0

To collect feedback from target audience, five of face to face playtests and interviews followed. The purpose of these activities was to grab general feedback and data collection methods weren't used, unfortunately. Because of this mistake, some detailed ideas are lost, but general feedback is safe. The procedure was quite simple: a participant is given a mobile phone with pre installed game, no explanation of the game or it's content follows. The participants are asked to share aloud their thoughts while playing. After the participant is finished the game they are asked to share their thoughts on the experience.

Game experience. Participants showed signs of curiosity because of the setting were nothing is explained. Participants showed understanding of game structure quite fast, understood the mechanics of locked doors, while showed little understanding on the purpose of the Art Book. Participants were following coins breadcrumbs and asking what these coins could be exchanged for. Participants showed interest in game setting, character and its animations. 3 of 5 participants won the first level, but as they reveal

later it was by accident. One playtest showed big holes in game design: at the beginning of the level player said "I want only to grab coins, don't want to read" and followed this pattern. The bad thing is that he completed the level without reviewing a single painting.

Feedback. While being positive on graphics, characters and exploration the participants showed very little interest in painting. Average time of viewing the painting in Art Book was around 1-3 seconds. So it seems that players didn't understand the purpose of the Art Book and moreover Art Book was scaring players away by its overflowing information. At the end of playtest players couldn't say the art movement presented in the level.

Conclusions. Analysis of game design based on the playtest results reveal a big structural problem of the game design: entertainment and educational parts were separated. Most of the game features were targeting entertaining and that's what grabbed players attention in the first place. Paintings and art book were the places which players wanted to skip. In this case it was obvious that this game falls to the category of "educational games [that] don't fulfil their promise of being fun and educational at the same time" (Ritterfeld at al, 2009). Fun and educational components shouldn't be separated in the first place, but thought as one concept. The game shouldn't split itself into studying here, relaxing there: all these components should be intertwined and create an experience where player couldn't say either they study or have fun at particular point.

Another conclusion to be drawn from here is an importance of playtests of the game in early stages of development. In this case playtest was conducted after whole production cycle, meaning that all the coding, art and animations were done properly and took a lot of time to finish. While testing game design in a row conditions with placeholder art and animations would take significantly less time and reveal essential problems at the stage where the work is cheap and can be thrown away.

Prototype 2. Art Curator

Grand Theft Art prototype showed very low educational results and its mechanics split education and fun apart. Core mechanics didn't work well which pushed this research to another iteration with the main requirement: keeping a harmony between game mechanics and learning content, not to split them apart.

"What people do with art, other than studying it and watching it in museums? How engaging is that?" - were the main questions. Well, the simplest answer is - people trade art pieces. Art auctions sell paintings for enormous amounts of money. According to Wikipedia, Salvator Mundi by Leonardo da Vinci was sold for $450 million and is the most expensive painting ever. The list contains more than 40 entries sold for over than $60 million.

"The Art Market" video series on YouTube introduces the way modern art industry operates. Four main components (art fairs, patrons, galleries and auctions) are interconnected and meant to influence each other. Galleries host various collections and interested in gaining publicity. Auctions sell art pieces to galleries or private parties. Art fairs actas networking event: they gather artists, critics and art curators in one place and enable networking. Patrons support artists' careers by buying their works. This model can form a core mechanics of a management game but it's far away from actual paintings.

An art curator, on the other hand, is a person who manages collections in a gallery. This role is closely connected to current movements, paintings and new visions. This person understands art from bottom to top: from colors to price tags. And this position seems like an interesting role to put a player into.
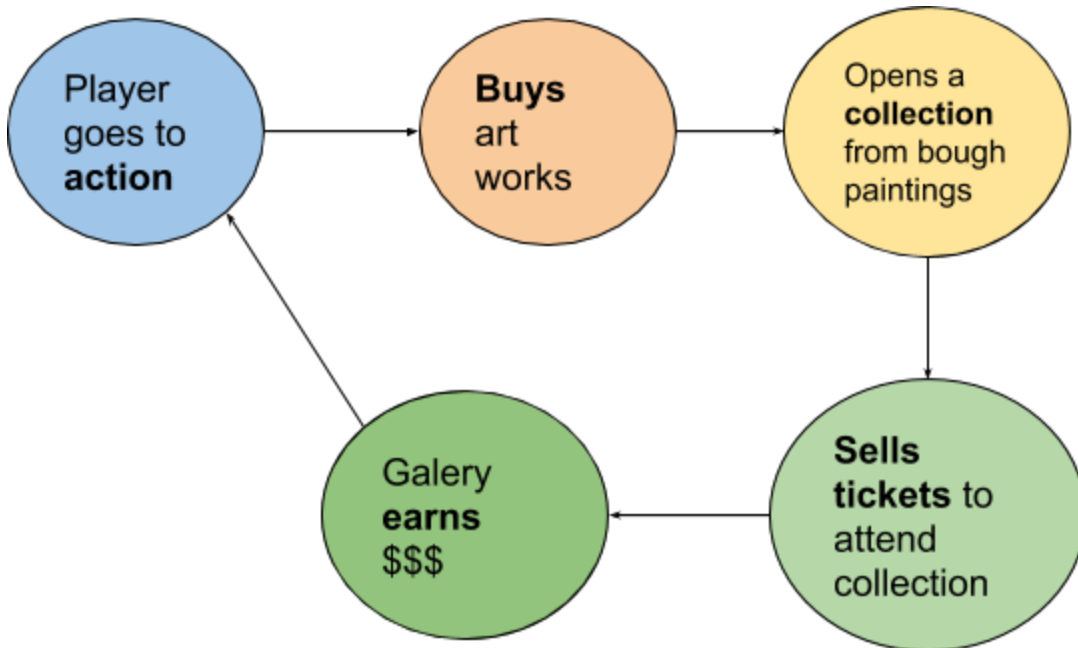
Core mechanics

Player's role is art curator in a modern gallery. His main goal is to maximize publicity of the gallery and it's income. Two steps are required to succeed.

1. Buy paintings on auctions
2. Form collections and open public exhibitions.

When buying paintings player spends gallery's budget, but exhibitions bring money back from ticket sales.
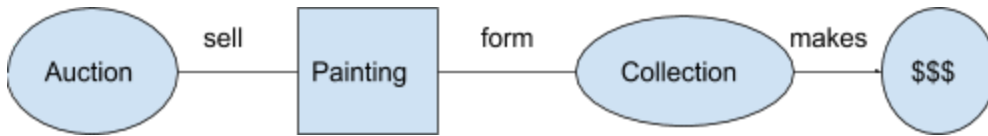

Main concepts and relations

Core loop of Art Curator

This loop demonstrates that art and paintings are integrated as game objects and take a central role in core loop. With that being said we could assume that harmony of game mechanics and learning content is achieved at the core of the game.

Painting as game object

In this game paintings or other art assets represent more than vague art piece. Each art asset comes with specified price, belongs to art movement/style, technique value, represent a class of painting like world, heritage, etc.; has aesthetics value and influence value. Making the knowledge structural enables game design to compare these pieces and use different mathematical functions with these values. The downside of this approach though is that at the end of the day art pieces are vague structures and it's

almost impossible to place "good technique", "not as good technique" on art pieces which are thought to represent culture heritage. But for the sake of simplicity and suitability for game design all the art pieces' properties(technique, aesthetics, etc.) were labeled by the author of the research and are fictional.
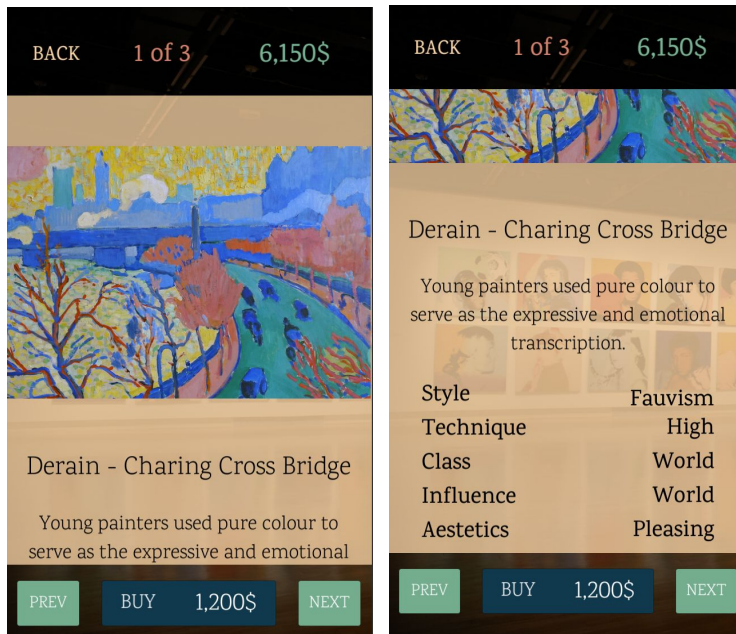

Charing Cross Bridge in a game. Note values of style, technique, class, etc.

Comparing paintings and forming collections

The idea to have a collection is simple: compiling several similar art pieces into one collection makes it more appealing to broader public and boosts the interest. Although "similar" pieces is a very vague term in real world, by structuring art pieces to have properties like technique or style it makes it easy to find similarities. Two art pieces may be similar when some of their properties overlap. Taking a step further, the degree of similarity in a number of properties that overlap.

Taking that into account we can introduce the concept of popularity of a collection: the collection is as popular as the pieces that form it similar. Which makes a collection to hold minimum of 2 pieces. When compiling a collection of say 3 pieces it's hard to find as much similar properties between 3 assets than two. That's why the more art pieces the collection has the more basic value is set.

Back to popularity of a collection: popularity of a collection influences number of ticket sales and ticket prices. The higher collection's popularity value the tickets are sold and for higher price. This puts a challenge for a player: create popular collections to have a high ticket income and earn more money.
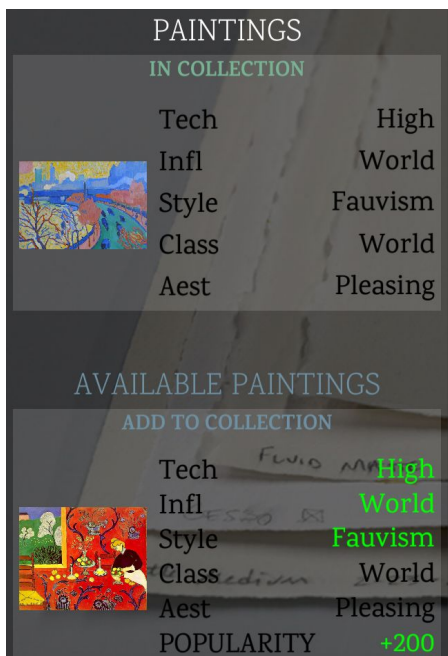
Similar properties of red and blue paintings is displayed in green.

Each collection is open for 10 days. Each day is iterated manually by the player and displays the income of the collection for a day. After 10 days passes the result screen is displayed showing the player how much did the collection earn. The result screen enables a shallow reflection of the player: player can compare how much money did they spend on the separate paintings to the collection income and see if it was worth it. Moreover, they can judge how well did they match paintings and how did they perform as a whole. A further development of this idea would be to present more clear and structured information about the past choices to the player at result screen to improve the quality of player's reflection and strategic thinking.

Learning environment and challenges

The auction can be thought of as a level. Auction sells a number of unique paintings usually from the same movement, meaning that all the paintings are similar and could form a profitable collection. Each auction holds on a specified day and gaps

between auctions are enough to run a collection, earn profit of it and with this profit come to the next auction and buy more paintings.

Auction forms a clear *challenge*: prices are getting higher each new auction. For example, first auction has minimum painting at $150, while second one - $1500. After the auction is over a price range of the next auction is displayed to the player stating a clear challenge: current collection has to earn enough money to buy more expensive paintings. Moreover, higher prices for the next auction *motivate* player to compile a decent collection and earn enough money to proceed. If the collection fails, player won't be able to unlock the game's content.

On the other side, auction is a *learning environment* as it presents a learning content in a descriptive way. First of all, auction presents a number of paintings from one art movement, say cubists, and creates a solid overall impression of a movement. The paintings are resemblant to each other, have similar patterns, technique and style which makes a dense atmosphere and look of the movement. Players can compare the properties of paintings, find similarities between them and make up his mind of what paintings will work together better in a collection. In turn how to compile a profitable collection and get over to the more expensive auction. This enables strategic thinking and evaluation of actions' and consequences beforehand.

After completing the last auction of the game and closing the last collection player gets a end screen, with statistical information, such as generated income over the game, number of visitors, etc.

Content

The prototype has 4 auctions, player's starting budget is $5,000. Scaffolding was used for balancing the difficulty of levels: auction prices and income from collections start low in a first level and grow with each level. This way design minimizes player's early mistakes and gives them a space to feel safe, while setting higher goals later.

Auction #1: Dada movement and two works worth $150-200. Duchamp is an only author presented at this auction. This is a tutorial level: player gets acquainted with a game, so there's a very limited safe space available.

Auction #2: Fauvism movement, 3 works starting at $1500. The works of Henri Matisse and Andre Derain are presented. Player might not be fully aware of the rules of the game still in this stage, so their paintings' options are still limited.

Auction #3: Cubism, 3 works of cubism, 1 from Dada and 1 from Art Noveau, min price is $2,500. Picasso, Braque, Klimt and Duchamp are the author presented. Note that only Picasso and Braque are cubists. While cubism's paintings match together properly, adding painting from Klimt or Duchamp will make up a low income collection. This is a first real test of player's understanding of a game: they need to compile cubists collection in order to generate a high income, otherwise they will get low income and won't be able to attend next auction.

Auction #4: 4 surrealism paintings only, starting from $20,000. Paul Klee, Giorgio de Chirico and Salvador Dali are the presented authors. This level requires a high income from previous collection as prices jump in 10 times. Also this level doesn't have any trick paintings so players are free to choose whatever they want.

Final product

The prototype was designed to be a short play, requiring not more than 10 minutes to finish. The game features a small portion of available paintings, a small portion of the auctions that could be held. Scaffolding was used for challenge design, although some prices and numbers may seem a little unbalanced. The prototype was ready with correctly implemented game mechanics & learning content, also it featured decent graphics and animations. The downside of this product is a lack of tutorial and unbalanced challenges.

Playtest

Art Curator design is based on trading mechanics, which means that players buy and collect art pieces. The educational part is integrated inside of mechanics. Knowing paintings' background (author, style, etc.) is crucial for the player to make a successful collection and earn game currency and proceed to the next auction. The design makes a tight integration between game mechanics and learning content and in turn could be used to address the hypothesis ("a harmonious integration between game mechanics and learning content can make learning games more effective").

Qualitative approach for experiment was chosen because of the nature of the prototype. The purpose of a prototype is to make basic functionality of the game with minimum production resources, which excludes such important parts as tutorial, in-game feedback and implies low quality of the game. With that being said, a specialized guidance is needed to playtest the prototype with a group of people disconnected from the study. This guidance includes defining games rules in voice before actual testing, helping those people who are stuck at some point in the game.

Interviews could reveal in-depth understanding of particular experience and provide a wide-range of player's feedback to the design of the game. For this particular playtest focus group interview is even more suitable, because it produces deep and meaningful information. The requirements for a focus group interview are 4-9 participants and a moderator (Krueger et al. 2001). Detailed preparation is needed: finding suitable participants, finding of a suitable place, defining key questions and even conducting pilot study. In case of this particular research pilot study was more than helpful.

Pilot study

Pilot study was conducted for this research to test and adjust prepared interview questions and to test the methodology in practical situation. One participant was chosen for a face to face interview.

Participant profile. A co-worker of the researcher was chosen because of availability. His name is Anton, 29 years old and he the quality assurance team leader at

a game company. He plays a lot of games, mostly action-shooters. He's working in the industry which means that he's familiar with specific game terms and the reflection on his experience could be meaningful and explanatory.

Questions. After initial brainstorm 30 questions were available. Following topics were brought to discussion after filtering of initial pool: first impression and emotions, in-game goals and challenges, paintings and metadata, reflection on player's purpose of the game.

Execution. Pilot study took around 40 minutes to execute: 3 for introduction, 15 minutes of playtest, and 22 minutes of discussion. It took 5-6 minutes of playing for Anton to understand the how to operate the game, what is the order of a play-loop and his part in it. Even after the presentation of the game rules before playtest, Anton needed additional support with tricky parts of the game. Example of his questions "Can I add painting to a collections which is already open? Can I reuse the paintings from ended collections?" etc.

Anton was speaking aloud while playing the game. One of his first strong reactions was regarding the Duchamp's 1917 *Fountain*, which is basically a urinal turned-upside down and is one of the most famous Dadaist heritage. When he saw it at auction he exclaimed "Is that real art? Do people really buy it?" - which is a very good result. Firstly, any reaction towards the art is good because it means that person acknowledges this piece and it resonates on some level. Secondly, Dadaism is controversial art and gained a lot of criticism which is essentially Anton's reaction. While browsing Dali's work Anton stopped for a while and said that he likes them. He likes the colors, how differently they portray familiar objects and just overall he's interested in those paintings. When researcher pointer out to other Surrealism paintings available auction, Anton couldn't identify with any other painting. All this shows that while playing the games Anton built personal preferences regarding some of the paintings.

Interview. After the playtest Anton was speaking about the trouble he had in the game. The lack of in-game tutorial was clearly an issue which stand on his way and he

wanted "the game to take my hand and lead me though its process initially". He showed the lack of understanding on "how do you make popular collection" and "how to match paintings", even though the game provides in-game feedback regarding the painting matching.

After the playtest Anton was very open to speak about art. He mentioned that "it's just interesting to view the paintings and its brief description. For the person who is not familiar with art and only knows Mona Lisa, reviewing different art was interesting". He was interested in reviewing more art content and exposed his newly formed preference to surrealism and Dali. But he mentioned that he wouldn't do additional research on the in-game paintings after the playtest. "It's boring to go through museum and watch collections. But managing the paintings and building the strategy is interesting".

Results. The pilot study showed player's interest for art content presented in the game. During the gameplay player formed its own preferences in art, after the session player could name paintings he didn't know before. Moreover, the player positively recalls his learning experience stating that it was interesting to see an art form game's perspective. All of these point to a positive confirmation that engaging game mechanics promote learning experience.

Question adjustment

Pilot study showed an importance of well-constructed questions and making them as ambiguous as possible. This way participants can express their own thoughts. So the questions were adjusted, for example.

- What is your first impression?
- Think back and describe your feelings about the game.
- What kind of the art did you meet in the game?

The playtest

Focus group interview was selected as a method to test research hypothesis. The method's vital component is participants and 4 persons were chosen to make up a focus group. All of the participants share advanced design skills and could reflect properly on

their player experience. Moreover, all of them have basic knowledge of art which means same ground for the discussion of what they learned.

- Jeroen, 24 years old, game design student, basic knowledge of art.
- Marie, 32 years old, game design student, basic knowledge of art.
- Martin, 20 years old, game enthusiast, basic knowledge of art.
- Olena, 22 years old, human-computer interaction student, basic knowledge of art.

Setting. Tallinn University provided the facilities to conduct the study. All of the participants were gathered in a round table to share their experience. 10 minutes of informal conversation started the meeting, together with snacks and drinks it seemed to break the ice between unfamiliar participants. The prototype game was installed on 4 mobile phones. All the phones came with headphones so that each user experiences the game on his own. One computer was recording audio dialog.

Process. The interview started with informing participants of the purpose of the study and its procedure. After the rules of the game and its goal were explained, participant started playing the game each on individual phone. After 2-3 minutes all of the participants were stuck on the first level of the game. To open the collection player need to have 2 paintings in it. Martin bought 2 paintings and put them into 2 different collections which means he wasn't able to continue the game. Jeroen, Lena and Marie, in turn bought only 1 painting on auctions and couldn't open a collection. Researcher told additional rule of minimum 2 paintings per collection and participants could proceed with a game.

After 5-7 minutes of gameplay more each participant informed that they went bankrupt. Third auction has paintings mostly from cubists, but there is one dada painting as well. By the game rules cubism art is incompatible to dadaism when put together they make low ticket sales. It happened that all of the players bought incompatible paintings, which generated low revenue on the tickets and none of them had enough budget to buy surrealistic paintings from the next auction. This was actually a bad sign, since it meant that users didn't understand the rules of collection

compilation. This could be fixed with detailed tutorial and making first levels less punishing. After participants understood additional rules they started from the beginning. Final play session went smooth: everybody finished the game in 7-9 minutes and the study could proceed to discussion.

Discussion. When asked on the first impression participants were talking about troubles they experienced during the playtest. "It's hard to grasp the game from the beginning" said Martin. "UX troubles" were reported repeatedly: at first players didn't understand what are the parts of the game and how they are interconnected. Collection management reported doubtful: users wanted to remove paintings from it (which they couldn't do), users didn't understand why draft collections are created. Jeroen reported minor troubles with the user interface: same colors of the button when enabled and disabled. Olena didn't get the progression of the budget at first.

This troubles were expected as game lacked any kind of tutorial. But unfortunately poor on-boarding process(in-game explanation of how the game works) influenced later experience as well, meaning that even after the questions moved to different topics participants were still reporting same problems they had with the game.

Speaking about strong feelings and emotions experienced during the game, Martin said that after the prices of the paintings started to grow he started wondering how does he make more money. Which in turn made him look closely at the stats of the paintings, which is essentially the correct way to make more money in the game. He reported that he understood that collection should have matching art movements to earn high revenue.

Jeroen reported disappointment towards the asset he bought in third auction. Third auction was mostly about cubists, but Duchamp's Bicycle Wheel was a trick painting you should omit. Nevertheless, Jeroen bought it and couldn't use it for his collection. He was basically "stuck with a painting I can't use". Olena reported the same problem with "bicycle painting", in her opinion "Klimt was out of style, and the bicycle suits better to the collection of cubists".

Jeroen also reported the lack of the player's options in the game. Basically you have to buy everything's which is on the auction to go further. He, as a player, wanted to have some freedom - to buy paintings on this personal decisions, not because that's the only way to proceed. "The lack of options was kind of disappointing".

Participants were positive regarding their role in the game, but again they wanted more options. The role of the art curator is interesting, Olena said that "I prefer to be in a positions of the curator than to be a mere visitor". Although, she reported later that she would like to take loans from a in-game bank. Marie said she wanted to sell the paintings she doesn't need any more. Also, participants reported they would prefer socialization in the game: watching other collections, checking what are popular streams now and adjust their collections regarding to it.

Main game goal was obvious for the players: each of them wanted to earn maximum money. Jeroen was not sure he did well on the goal, because he couldn't understand if his choices were correct or incorrect. "I was earning money from collections but is it enough? If I would make a collection in a different way, would I make more money?". Moreover, the price gap between the levels was high: third level paintings cost $2,500-3,500, while fourth level: $25,000-35,000. "I thought I was doing well on the third level, because I was earning more than on the 2 level. But when the fourth level came I just couldn't buy anything" - he talked about first gameplay bankruptcy. Although the game feature this feedback and the prices for next auction were in the game all the time, it seems that none of the participants actually saw it.

Participants could report couple of game challenges they had. Olena went bankrupt on the first try and this was the challenge that she failed. She reported that understanding of game functionality was a challenge that she completed successfully. Marie saw a bit smaller challenges: completing the level and accessing new paintings at auction was a challenge for her.

The most anticipated question for the discussion was "What kind of art did you meet in the game?". Participants could recall all the art movements presented in the game. The "bicycle painting" was the first specific painting pointed at. Players could

recall Dali, Picasso and Klimt as authors. Olena's confession was that she didn't read painting's info, Marie confirmed the same. Participants report that they were busy with understanding game and didn't look at the paintings that close.

Participants had a lot of different opinions on the purpose of the game. "To interview art managers", "To educate children about famous art paintings", " to see how different paintings match together" and the 10 point answer on the 10 level scale "to give more structured knowledge about art". Participants clearly had the right impression of what the game aims at.

Results

Although the game was a bug free and completely operational its on-boarding process wasn't friendly. Nowadays, explicit tutorial is very often omitted: players skip it and want to have a hand on the game on their own. Modern games tend to build the first levels in a sandbox mode: no losing conditions and only one available action at a time. This way players experience basic game actions on their own and can build a mental model of the game before being exposed to win-lose conditions. Art Curator tried to use the same model, but had a hole in a game design: players could get stuck in the first level if they put two paintings into different collections. Everybody from the focus group happened to stuck in the same place at the first try, which caused confusion and disappointment and polluted whole player experience heavily. Moreover, the game used even more implicit rules, which were not exposed to the player and caused more confusion. The conclusion to be drawn from here: the game should have very clear rules which the player should be aware of. Even some minor rules which are not shown to the player can cause confusion and pollute whole experience.

Extensive feedback should be seen by player. Couple of the works in game feedback were analysed in literature review part of this work and influenced game design. For example: the prices on each new auction grow rapidly in the game. Which means that player should have a clear understanding of how much money they are expected to have in the next level. To support this the "Auction" button in lobby had a label with min and max prices of the next auction.
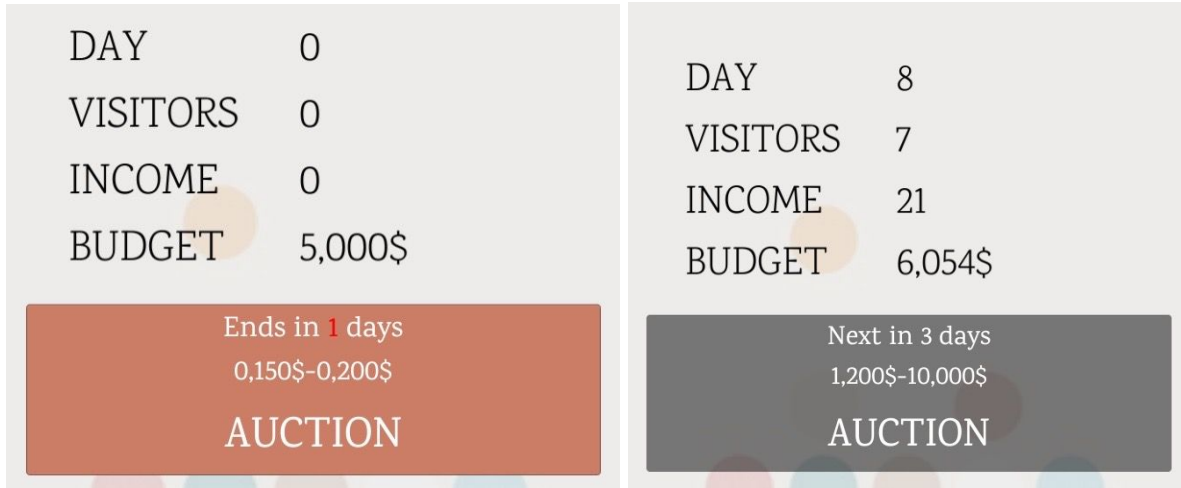
Active auction is displayed in the first image. It's price range is $150-200. Second picture shows that next auction is coming in 3 days and it's price range is $1,200-10,000. This seems to be a perfect place to inform user of future requirements.
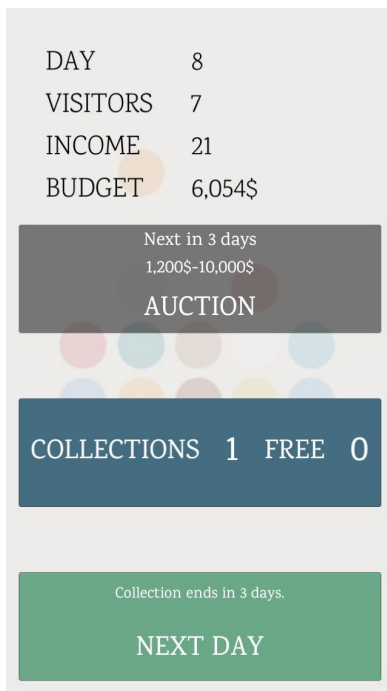

Lobby game screen. Next auction price range doesn't stand out and seems not important

Nevertheless, all participants report that they didn't know what price range is expected in the next auction. Players thought that they're doing well in the game if their income was higher than in previous round, while the actual goal was much higher and

minimum price jumped from $150 to $1500. This caused players' misunderstanding of the game goals which caused each player to go bankrupt in the first try.

So, in this case the price range should be put in a more vivid place like header of lobby screen, large font size and bright text color could also help. Different form would be even better: after current auction is over and the next one is scheduled game could present a separate explicit screen telling the player what are the price ranges for the next auction and maybe even the art works. Most of the players expressed a desire to sneak peek art works in a next auction to change their current actions accordingly.

Problems with clear understanding of the game rules and vivid feedback influenced player's lack of understanding of paintings matching mechanic. When combining a collection each painting shows how much it will contribute to overall popularity of the collection.
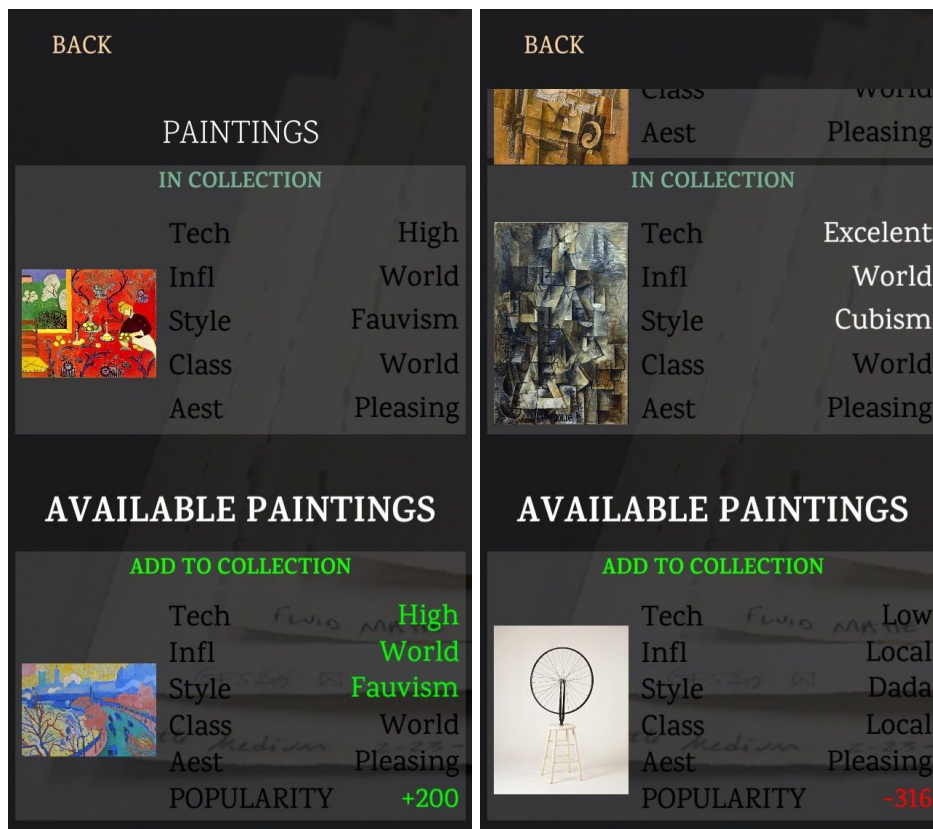
Adding a painting on the first picture will increase popularity of the collection in 200 points. While the second picture shows how adding a painting can harm overall popularity of the collection in -316 points.

The game didn't show players the relationship between the popularity of the collection and how much money the collection will earn. In turn this made players ignorant of why they should pay attention to popularity stat. This in turn lead to poor decisions when compiling the collection, low revenue and bankruptcy in first try. It's obvious that players were choosing the paintings on the auction relying on their personal preferences and intuition, and not relying on the understanding the game rules.
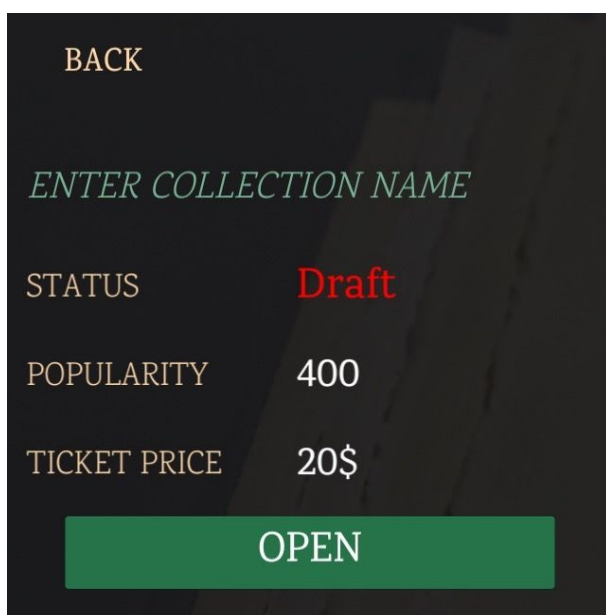
Collection statistics. Popularity and ticket price is shown to the player, but total income from the collection is hidden.

All of these problems came with a cost of low attention to learning content. Players were busy with understanding overall principles and hidden rules of the game, analysing their failures. Game design didn't support decision making and learning of the game mechanics well enough, which in turn took most of the players' attention. For example, if the players were fully aware of collection compilation rules and paintings matching mechanics they would pay the more attention to paintings stats and how well

do they match together. Understanding the paintings stats would supposably lead to deeper understanding of each painting meta information, connection to the art movement and to art world in general. Unfortunately it didn't happen in this study.

Players report overall interest in the art of the game. After playing the game participants could name all the art movements together, most famous authors and could tell what paintings match together (based on their own opinion of course). Moreover, participants report satisfaction with their in-game role. Again, direct citation of one of the participants is "I prefer to be in Art Curator's position than a mere viewer at the museum", another one "It's boring to go through museum and watch collections. But managing the paintings and building the strategy is interesting".

Conclusions

Process overview

The vital hypothesis of this research is "A harmonious integration between game mechanics and learning content can make learning games more effective". A number of steps were taken to address this field: literature review, design of a game mechanics supporting learning of art, playtesting the prototype. Literature review revealed major factors of game design that support learning: game mechanics, motivation, reflection, challenge and safe learning environment. These findings made a theoretical basis for the design of educational game about XX century art. The game presented a unique role of art curator whose main responsibilities are finding proper art assets at auctions and forming collections. The learning content was integrated into the heart of the game to support research hypothesis.

The successful development of a mobile game prototype followed. The game included 4 levels, 14 paintings and 10 authors. To test the game focus group interview was scheduled, pool of questions and format. Pilot study of face to face interview was conducted to reveal first impressions, and test which questions open better the topic. Finally, focus group playtest and interview with 4 participants closed the studies.

Major findings

Pilot study showed an evidence that integration of game mechanics and art content was successfully implemented since the player positively recalls his learning experience. However, first conclusion of focus group playtest was negative. Players report a confusion regarding implicit game rules not presented to players, which polluted later game experience. Major conclusion is that games should be very honest with players and explain every minor rule to the player. Not understanding game rules leads to player's distrust and harms their game behavior.

Speaking broader, conclusions from playtest and participants' opinions confirm that trading mechanic is engaging and suitable for learning art. This mechanic offers "more structured knowledge of the art", presents the art assets with detailed description and enables players to compare art pieces. Moreover, interaction mechanics were met

with a very positive response and reported to provide an engaging way of studying art. An ability to buy, collect and make in-game money from a painting has a higher engagement that merely going to museum and seeing the pieces. After a 10 minute playtest players report personal preferences and internal connection to some of the art pieces.

Initially trading mechanic promised to have deeper learning outcome though. Unfortunately, poor presentation of the game rules and inappropriate feedback stood in the way of learning. With this in mind, the study could suggest that hypothesis is right, but could not confirm it 100%. Researcher personally believes that by fixing the problems that stood in the way, players would be much more engaged into the game and learning results would be much better. Unfortunately, another iteration over whole research process is out of scope for this research paper.

Discussion

Educational games is relatively new field and there's a lot of open space for future research. Educational games is a field that promises to create a new entertaining way to conduct learning. Some decent examples like *September 12th*, *Human Resource Machine EDU* present such fundamental and complex problems as terrorism in a simple way or merely teaches the basics of algorithm building in an appealing way.

However, game production is a very expensive process. Commercial game production teams usually consist of minimum than 4 people and game projects of minimum scope take 2 month to develop with a minimum budget of $10,000. Design of learning games require extra time and resources since it should support learning as well as engagement. This also requires project's budget to grow.

On the other side, the expected outcomes of educational games are not so evident: should it be only to extend problem solving abilities of the player or teach specific content. Let's assume that we're expecting an educational game to teach some specific topic. Making a full game to teach a specific topic requires a minimum budget mentioned above and it's not so evident if it's worth it. Having a proper class with an

interesting teacher would actually have the same effects as playing the game, while the costs would be drastically different.

Another advantage of games is scalability: a game project could run on any computer of mobile phone. This means that one project could be used anywhere in the county or even the world. For example, in 2012 there were 11,471 new students admitted to vocational education in Estonia (Statistics Estonia, 2012). So if game's project is still $10,000 than development prices lands in less than $1 per a new vocational student. Which leads us to an issue that educational games don't see a support from the government, but promise advantages on global scale.

Games are perceived to be fun and when a student hears that they are going to play a game they imagine spending fun time. Educational games require more than interest from a student: to properly learn from the game player should be dedicated to content and have their own motivation to learn. While educational games are rare examples of game, a stereotype like "fun game" exists. With more successful examples of educational games that offer more than fun, occurences of this stereotype should decrease and even new stereotypes like "new game - a new interesting content" could emerge. But this requires educational games to have a high publicity: the more projects are available the higher this chance is.

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