A Thin Light Blue Line - Towards Balancing Educational and Recreational Values of Serious Games⋆

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Abstract. With mobile games becoming best sellers in app stores of Google and Apple, more and more research interest is put in this field. Practical applications of games, however, may surpass sole entertainment and bring educational value to gaming experience. Such undertaking, under the name of serious games, has been actively explored in the academia and beyond. Numerous previous attempts at educational games brought significant insights into the edutainment area, which inspired us to garner the advantages of their ideas. In our work, we demonstrate an architecture of a mobile game with location data enabling context-aware play, which implements affective game design patterns for greater experience of cultural heritage of Cracow. Additionally, we identify several research questions and propose methodological approach to verify them.

Keywords: serious games, educational application, context-aware systems, affective computing, mobile devices

1 Introduction

Since its first concepts, which occurred in the nineties [31], Affective Computing (AfC) has become a well defined area on the intersection of psychology, philosophy, neuroscience and computer science, aiming at using emotional states to enhance usability, flexibility and immersivity of computer systems. Soon after, Affective Gaming (AfG) has been recognized as a field that lets to test solutions which acquire this aim in the best way.

That is why in our previous works we started with creating games based on Affective Game Design Patterns [25] and then extended the idea with prototypes implementing the Affective Loop [13,27]. Simultaneously, we investigated into the

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⋆ Light blue is the codified color associated with the academic field of education, according to the United States Intercollegiate Bureau of Academic Costume.

area of context-aware systems that can be used for ambient intelligence [26]. As we focused on building more pervasive and immersive environments, we turned our attention to smartbands and mobile platforms [20].

This work is an attempt to merge our early ideas with AfC, context-aware systems in the field of serious and educational gaming using mobile phones. The rest of the paper is organized as follows. Firstly, we discuss serious games for educational purposes. Then we provide information about affective and contextual elements in such applications. In the next sections, we describe *Meet Cracow*[1], a developed prototype of a mobile game. Then we discuss our early ideas regarding testing the application and we provide an outlook for our future works.

2 Serious Educational Games

Conjoining seemingly contrary concepts of playing and learning has been present in the research area for nearly four decades. Looking as far as back to 1970 [1], serious games carry a definition based on their targeted effort, which surpasses sole recreation. Essentially, this means that a serious game is one designed and created with purpose other than entertainment. To date, serious games have been used in many contexts and bore a variety of applications —ranging from education and therapy to simulation and training, and as transmitter of certain social or cultural ideas.

The idea behind incorporating games into serious purposes lies within their capability to engage learners, challenge them, and encourage them to solve specific problems using acquired knowledge [15]. Although definitions of 'game', 'play' and 'game play' tend to vary greatly, majority of them agrees on certain components [12,6,14] — that games involve operating within some constraints or rules that the player willingly chooses to comply with. Another characteristic of games is their focus on providing a form of feedback to the player's actions. Aside from rules, the player is often hindered from achieving the game goal too early and too easily by being made to face various obstacles (i.e. diverse kinds of enemies, traps or other in-game hazards). Moreover, the game often provides a narrative, which makes the player involved in the story being told as one progresses through the game. These challenges invoke a sense of engagement, attachment to the game outcome, and sometimes even competition (or cooperation, depending on the context) — which makes games a very promising area for applying learning and teaching techniques [32].

Many researchers point out that academic approaches to serious games have a fatal drawback, which impedes their positive evaluation in terms of educational value — the lack of comparison between game-based and traditional learning techniques. Moreover, [9] claims that this aspect is actually neglected by most of the studies. Indeed, practical validations of instructional effectiveness of games are scarce. However, when they do appear, the findings are quite encouraging. According to [34], around three-quarters of reviewed social science games

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[1] Code available at home.agh.edu.pl/pjm/research/solutions/meetcracow

or simulations show no difference between games or simulations and classroom instruction.

A more recent review by [3] suggests that serious games in general have a positive effect on learning. [45] showed that the student motivation increased in the game based educational strategy variant of their study group, comparing with the control non-game based variant. The benefit of such results is that games can be used safely as an educational tool, without detriment in the academic aspect.

Aside from learning, serious games are eagerly used in various different contexts. For example, a recent systematic review [43] indicates great benefits that tourism field may gain from applying gamification techniques. Learning new facts on the culture of different nations and countries can be brought into a new level with contemporary technologies. Furthermore, modern users are demanding in terms of quality of the experience they are provided with, especially in the context of learning. Thanks to the interactive and engaging nature of games, even people who struggle with getting involved with exploring the history of important places and persons may become immersed in the experience. Games often give possibility to adapt another existence (as an avatar) [28] and provide challenges and missions that link the virtual fantasy and the reality [44]. For example, *Eye Shakespeare* app enhances the visit in the famous poet's hometown, enabling to use augmented reality to discover interesting facts related to Shakespeare when on site in Stratford Upown Avon[2].

3   Re-purposed Games

As mentioned before, serious games is a term that encompasses those games that, from the moment of their conception, are designed to bear purpose different than just entertainment. It might be confusing that, despite many years of studies that confirm the positive effects of using games in teaching, educational games' presence is not that great, and edutainment market is not overflowing. One of the main reasons, which also proves to be an important problem regarding educational serious games, is that it is difficult to design and create a good serious game, or to re-purpose an existing commercial game for serious applications (the latter observed i.e. by [8,10,16]). Regarding the latter, which seemingly would be a more viable strategy (since commercial design already presupposes much impact placed on player experience and fun, without being 'distracted' by following strict educational guidelines), high amount of irrelevant content and functionalities is perhaps the greatest trouble. [35] propose conceptual guidelines for appropriate educational game genres in relationship to learning techniques, activities and content, and [2] use the assumption that educational games should resemble commercial games that students play in their leisure time. They prove their point with an engaging educational video game

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[2] Unfortunately, the app does not seem to be supported anymore (September 15th, 2019). The reader can however have a glimpse of the game functionalities at dailymotion.com/video/x2vr0vw

that they developed, which teaches children basic mathematical concepts. Their game hones hand-eye coordination and quick reactions, while fulfilling standard educational requirements 1.

Fig. 1: A screenshot of an educational game developed for research purposes by [2].

In order to tackle the challenge of good educational game design, [11] propose a RETAIN design and evaluation model (*Relevance*, *Embedding*, *Transfer*, *Adaptation*, *Immersion* and *Naturalization*). In essence, the crucial feature of an educational game should be that it forces the player to use previously gained (academic) knowledge in order to progress within the game, and not only the skills and mechanics trained during the game. Furthermore, the game's academic content needs to be endogenously immersed in the game context and storyline. These findings are also supported by a recent alternative proposition from [41].

4 Mobile games for games generation

[33] contends that contemporary students come from a *games generation*. He describes descendants of this generation as individuals who prefer graphics over text, have a 'random and informal' approach to information, treat learning as a social activity, and expect an immediate pay-off of their academic efforts. Moreover, they conceive knowledge as a consumable item, which is retrieved and used when needed. This idea is recognized by [11] as one of the reasons why most of educational games fail. We suggest that the very nature of using mobile devices is pretty much in line with this perspective — a student can grab a mobile device and find the needed information just when it is needed, and, what is more, they can do this almost anytime and anywhere. Relying on this line of thought, we developed a game prototype that benefits from mobile pervasiveness, as well as addresses other needs and characteristics of *games generation*.

The educational and gaming landscapes of mobile learning have been thoroughly covered e.g. by [17]. Well-designed mobile games can use the physical and

social context. The whole concept resides within two underlying theories: constructivism (meaning that people learn by constructing their own understanding of principles and phenomena, e.g. [30]) and situated learning (where learning is a social activity, embedded in the student's life [21]). This leads to social, meaningful, authentic, world-connected, open-ended design. We would like our games to be location based, considering the theme of Cracow cultural heritage. Location Based Mobile Games (LBMGs) bring pervasiveness, which contributes to richer player experience [39] and reinforces positive effects of educational games.

5 Affective and thus effective

According to [40], the field of educational games has stagnated. He argues that in order to break away from this stillness it is necessary to consider and actively involve the affective component of learning, in various ways. The recent paper by [5] also identifies significance of affective learning component. Emotions are either at the heart of learning [19], or inseparable from meaningful and sustained learning [23]. Therefore, we also believe that the use of AfG solutions is the next step on the way to popularize games as a teaching tool.

Some game mechanics themselves are inherently capable of evoking emotions in the player. Game mechanics, understood as such mechanisms that enable interaction with the game world, can be described in terms of game design patterns, as proposed by [4]. Among the patterns identified by the authors, one can distinguish several that, when applied to the game design, enhance the affective level of the interaction with the application.

Setting out from the serious games and AfG ground outlined above, in the next section we present an early prototype of a location-based affective mobile serious game, and provide a description of its educational value. Firstly, in order to elevate the motivation and engagement, we want to remain as close to commercial game quality as possible. In our approach, we do this by staying close to the real life and involving game puzzles related to real world's culturally significant locations.

6 Context-oriented games

Use of location in mobile gaming is not a new idea. For example, authors of [24] developed a game called Real Tournament based on GPRS and IEEE 802.11 hotspots. The main aim of the game was to cooperate with team to move around the city in order to find and capture as many monsters as possible. Similarly, in [22], such knowledge also was incorporated in order to allow fighting against opponents located in the same area.

With the GPS sensor included in every smartphone, contextual information became more available in apps used by millions of people everyday. Apart from using it for navigating purposes, more and more game developers such as Niantic with its *Pokemon GO* or *Ingress*, releases productions based on location services [36], extending physical sensations with Augmented Reality.

It should be noted that context-awareness goes beyond GPS or other location systems. It is rooted in the knowledge of in-game and real world situations. Therefore, it can be related for example to personality of the player, their emotions in Affective Loop systems, state of in-game parameters or even dinner plans of the player.

7   A mobile game for cultural education

In the light of previously described aims for educational serious gaming, we have recently developed a mobile game, with cultural heritage of the Polish historical city of Cracow as its theme. The game prototype was created using Unity engine for Android devices. The gameplay is oriented around letting the player freely explore the city, and to educate them about the culturally significant objects or facilities that they encounter on their way.

The game is location-based, meaning that the gameplay is closely related to the player's physical location in the real world. As the player roams freely and explores the city, when they approach a certain object or facility, an opportunity for solving a puzzle or playing a minigame is activated. Whats is more, thanks to Android GPS Services, the user is able to see their distance to predefined locations and choose a destination to which they want to head. In the compass scene, the target's direction is presented. Contrary to other games augmented in real world like *Pokemon GO*, *Meet Cracow* does not implement full map view. We believe that using compass can improve immersion of play by recalling the historical times. When the player is near the object (closeness is defined within the app settings), the puzzles and minigames are activated. They are thematically related to the object of interest.

Currently, three types of game-activities are available. The first one is inspired by tiling puzzles which depict the approached cultural object. For example, when approaching the Wawel Dragon sculpture, the player is presented with a jigsaw puzzle depicting the scuplture. After solving the puzzle, the player is rewarded with interesting facts about the Wawel Dragon and its legend.

The second type are action minigames. Although quite loosely connected to the educational aspect content-wise, they offer probably the greatest entertainmnent among the available game-activities. In the action minigame, the player uses their phone to maneuver a dragon through a sky of other system-controlled dragons. The objective is to avoid collision with other dragons for a specified amount of time. In the case of success, the player is presented with information on the location that triggered the minigame.

The final type of the game-activity are quizzes which test the player's knowledge on the cultural objects that they encounter. While this activity may appear less entertaining than the previous two, it possibly bears the greatest educational value. In order to ease the player and not to pose too much of a stress on them, there are no harsh consequences of not choosing the correct answer on the first attempt. If the player chooses a wrong answer or fails to choose any within
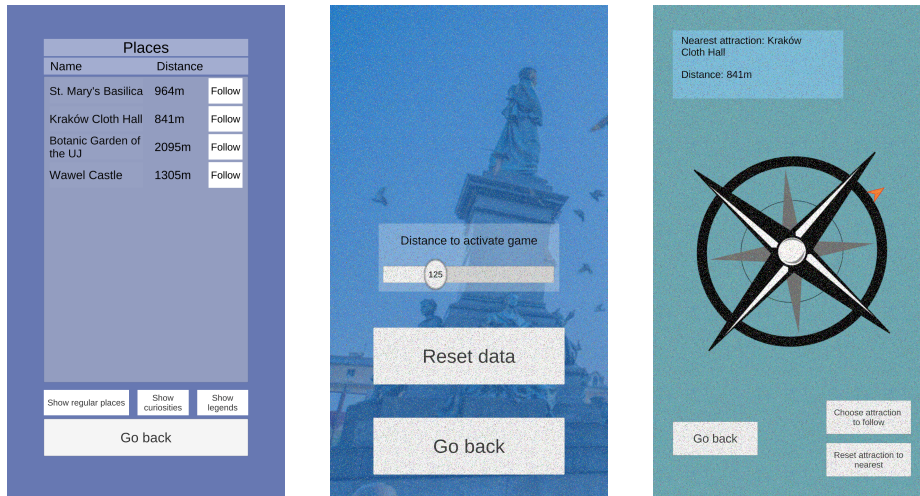
Fig. 2: Three screenshots of *Meet Cracow*, presenting the view of nearest points of interest (left), app settings (center) and the compass scene (right).

the specified time, the correct one is highlighted and the player can use this knowledge in the next attempt of the quiz.

The culturally significant locations are divided into three categories, which enables each player to focus on their favorite aspect of the cultural heritage. Firstly, **Places** are physical objects, buildings, sculptures etc., which the player may approach and see in the real life. Next are **Curiosities**, which form a broader category. They can include buildings, sculptures and commemorative tablets, but also streets or plazas. They refer to any element that is somehow connected with an important person or event. Finally, some **Places** or **Curiosities** may be associated with a **Legend**, which is another category on itself. Legends are narratives which fascinate many people, so those players who are more keen on the elusive charm of the history and culture will probably enjoy these objects the most.

All mentioned elements are implemented as separate modules within the game, therefore application could be easily extended by placing new locations in databases or development of new activities such as other minigames.

Apart from being context-based and educational, the game itself is also intended to be affective thanks to use of game design patterns [4]. For every task in the game, user receives points that accumulates as he or she move around the city. Then, player is able to see their results comparing to others. All results are stored on the server. These elements refer to the patterns *Score* and *High-Score List*, which evoke the thrill of competitiveness. What is more, if the player wins a minigame, they gain access to the **Inspirational learning** scene, where additional, most interesting facts connected to the place are showed. On the other hand, failing to win the game results in temporary block to re-access the
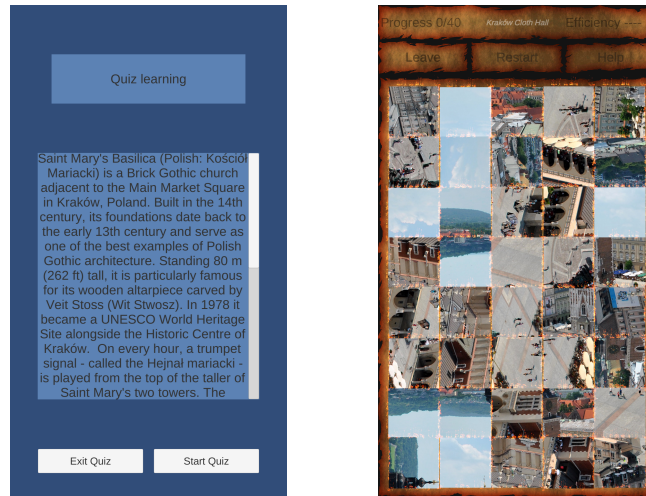
Fig. 3: Example minigames that the player can activate when plaing the game: a quiz and a jigsaw puzzle.

minigame. Those two features are related to the patterns **Rewards** and **Penalties**, which raise respectively positive feeling of victory and negative feeling of defeat.

The aim of the experience is to let the player who investigates the cultural heritage of Cracow do this in a novel, entertaining way. The game is mobile, so it can be played by almost anyone. Using the content categorization we respond to the need of considering different types of players, with different preferences.

8   Preliminary evaluation

Meet Cracow is currently still undergoing many development processes, but the operational prototype is fully test-ready. In the anticipated pilot study, we intend to compare the users' experience and performance in two conditions: with a tourist guide but without the app, and without a guide but using the app.

Using such experimental manipulation, we expect to identify answers to the following research questions:

1. *Does* Meet Cracow *improve the effectiveness of learning of cultural heritage of Cracow?*
   We anticipate that the answer to this question will prove positive. Considering the previously conducted studies [3], and following the arguments provided in the sections 1, 2 and 3, we believe that the mobile medium and game-based mechanics will be sufficient for visible improvement of the recall and the level of detail of the studied material.
2. *Does* Meet Cracow *provide good enough usability to the users?*

We are quite optimistic about the user experience of the game. Nevertheless, we see plenty of room for improvement regarding the user interface, quality of puzzle design and quantity of different minigames and graphical assets.

3. *Do the affective mechanics enhance the user experience?*
   We believe that the effect of the affective mechanics have a chance of emerging already in the present state of the game. Regardless of that, we are strongly inclined to deepen this aspect of the design, and include much more refined approach towards the emotional layer of the player experience in *Meet Cracow* – not only in terms of implementing more affective design patterns, but possibly by engaging algorithms and tools for affect awareness, i.e. AWARE [42] or Koko [38].

4. *Does contextual part of the game improve the immersion of it?*
   It is almost certain for us that bringing the experience closer to the real-world context, and the learning process closer to the studied material context at the same time, will positively influence both the immersion on the level of gameplay and the quality of learning simultaneously. We support this claim by invoking psychological studies on the information recall enhanced with context [18,37] as well as judging by the contemporary popularity of context-based and location-based games [29] together with VR experiences that bring the immersiveness of the context to the higher level.

9 Looking forward, conclusion

We acknowledge that our prototype is still in early development, and therefore we plan to further improve it in our future works. Following [7] suggestions, we intend our game to include a user-friendlier GUI, allow for synchronous play between different players, and generally represent commercial quality in terms of development. Moreover, with regard to the RETAIN model [11], we want to fine-tune the design so that it will better fit the model's requirements.

We recognize possible risks regarding the future development of the game, and with the still upcoming practical evaluation of its current version. With the necessity of work on commercial-quality development and educational value at the same time, there is a need for more human resources. That is why we want to divide the process of game creation into two groups. On the other hand, separate teams (one for educational purposes and one focusing on development) can also generate issues themselves – communication, production, etc.

From the current perspective we can say that we have probably spread ourselves too thin in terms of so many aspects: mobile, serious, educational, historical, game, affective and location-based. It is difficult to tackle them all well. The outcome may be that the balance between educational and commercial value is still outside our grasp – something new still has to be found to marry these values.

Confucius is attributed to having said that: "Tell me, and I will forget. Show me, and I may remember. Involve me, and I will understand.". Relying on that, aiming at making the learning process as engaging as possible seems only natural.

Thanks to years of research on educational methodologies, human cognitive and emotional capabilities, and modern technological advancement, nowadays we may be witnesses of birth of a new learning paradigm. As each of these areas has clearly expressed needs and solutions, it is possible that resolving their nuances is only a matter of bringing the findings of these disciplines together.

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