A Paradigm for the Development of Serious Games for Health as Benefit Delivery Systems

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***Abstract*—Serious games are developed with the purpose of bestowing a benefit on the user. That benefit could be related to the user's health, education, safety or efficiency. We propose that the mechanism that the game employs to achieve such a benefit should be identified as the key to the development of a successful serious game. We introduce a paradigm for the design and development of serious games as benefit delivery systems. We suggest that the paradigm can apply to all applications and genres of serious game. Three serious games for health are employed as case studies of developing a serious game as a benefit delivery system. Recommendations are then made for the adoption of the paradigm for serious gaming in general.**

I. Introduction

Serious games for health have been applied across many fields in recent years. Successful serious games projects have also been developed for education and commercial enterprise. The prime motivation for their use is quite intuitive: the user engages with the enjoyable game-play while some intended benefit or information gathering occurs. The benefit is, to some extent, smuggled over to the user who is distracted by playing the game. The interactive mechanic whereby benefit is delivered to the user is the prime motivation for utilising a serious game in favour of a non-game related solution.

To date, the categorisation of serious games has generally been based on either the field to which the game is applied (e.g. health, education, finance, etc.), or the genre of game which is employed (e.g. strategy, puzzle, sports, simulation, etc.). However the specific benefit to the user and the method whereby it is delivered can be very diverse within these categories, while sharing common aspects with games in other categories. For example, games for rehabilitation of limb movement after stroke rely on repetition of movement of the affected limb. Similarly a game which provides safety training in the workplace may involve repetition of tasks within a simulated environment.

We propose that the central paradigm for the design and development of a serious game should be the method whereby the benefit of the game is delivered to the user. Across the fields of application for serious games, and across the game genres that can be utilised, there are common mechanisms for the delivery of the benefit of the project to the player. The two examples in the previous paragraph both use repetition of action to deliver two different benefits in two different areas of application via two different game genres. Our proposal is that this *benefit delivery mechanism* (BDM) should be identified early in the design of a serious game, and all subsequent development should be in support of that mechanism. We suggest that the BDM is the key to success for a serious game to achieve its goals, and present a paradigm for serious games as benefit delivery systems, showing how the approach can be incorporated into the development of serious games in any field of application.

We present three case studies of serious games for health, which were developed by the authors, discussing them in the context of their benefit delivery mechanisms. We describe how adhesion to this paradigm informed the development of each of the projects, ensuring resources remained focused on the key elements throughout. Recommendations are then presented for the application of this approach to serious games in general. For the first time the method whereby benefit is conferred to the user is considered to be the central paradigm for development of serious games.

II. Background and Related Work

Serious games have been applied in many diverse fields, and some work has taken place attempting to unify their classification and application. As our proposal is a paradigm for the development of serious games, this section will focus on existing taxonomies or classification systems for serious games, and common methodologies that have been employed in their development, rather than focusing on specific serious games projects.

A. Classification and Taxonomy of Serious Games

As the topic of serious games has a wide-ranging set of applications, work has been carried out in attempting to classify serious games projects in a taxonomy. Some classification systems acknowledge that the proposed taxonomy can be applied to any field of serious games, whereas others focus on specific areas (although in most cases the specifics could also be applied more generally).

The seminal taxonomy for serious games for health was presented in [1] and is described in [2]. The taxonomy is a two dimensional classification system based on the type of health uses of a serious game (preventative, therapeutic, assessment, etc) and the stakeholders in the outcome (personal, professional practice, research, public heath). The focus here is entirely on the outcome of the serious game rather than the method whereby it is achieved.

An alternative approach is to base the criteria for a taxonomy of serious games on the features of the game itself, as well as on the application area. The taxonomy proposed in [3] lists nine such criteria for the classification of serious games (application area, interaction technology, game interface, number of players, game genre, adaptability, performance feedback, progress monitoring and portability). It can be seen that, while the work was presented as a classification system for serious games for health, it could be just as applicable to any field of serious games.

A taxonomy specifically for serious games for dementia is described in [4]. This also uses a two-level approach, classifying serious games by their health function (eg cognitive, physical) and their health purpose (eg rehabilitation, assessment, prevention). A further taxonomy is described in [5], which classifies projects according to the three parameters of game-play, purpose and scope. This classification system combines the approaches of [1] and [3] as it incorporates both the intended outcome of the serious game with the features of the game itself.

For educational games, a taxonomy was presented in [6] which utilises a four-dimensional classification system based on primary educational content, primary learning principle, target age group and platform. This was expanded upon in [7] with the introduction of a series of tags or labels including subject matter, learning goals, learning principals, target audience, etc. Of particular interest here is the *learning principles* tag which is the method whereby the learning is achieved (eg verbatim memorization, exploration, observational learning, trial and error, conditioning). Our proposal is that the method for achieving the benefit of the game should inform the paradigm on which the development of a serious game is based.

B. Paradigms for Development of Serious Games

The development of a serious game entails all of the challenges of both software engineering (where there are many well-known development methodologies) and game design (which must include the less well-defined challenge of providing entertainment to the user). Additionally serious game development requires solutions to challenges related to the specific aim of providing benefit to the user. In this section we focus on existing paradigms for development of serious games.

A comprehensive set of guidelines for developing serious games for health was published by the the US National Institute for Health [8]. The work takes the form of a FAQ for developing serious games for health from a team of experienced developers of games for health. The guidelines cover a broad range of topics. Of particular note are sections providing advice on ensuring that the game delivers the required outcome in terms of initial behaviour change, as well as maintaining that change. Further sections deal with more general topics as diverse as creating an engaging game design, funding the development, planning the project, and working effectively with a multi-disciplinary team during development.

Agile software development methodology is applied to serious games development in [9]. The paper describes how each process in agile development can be applied to the development of a serious game. A more comprehensive study of how commercial development practices for the games industry can be applied to serious games development is presented in [10]. The work includes recommendations for both effective game design specifically targeting the issues around serious gaming, and development methodologies from the commercial games industry.

A specific model for building serious games for exploring the cultural heritage of a city is described in [11]. A top-down methodology is described, starting with the extent of the area to be explored, and focusing down to the particular sites of interest. The methodology produces an explorable three-dimensional environment with embedded two-dimensional mini-games providing the experience of cultural learning. In this approach, users are encouraged to explore in order to learn.

A number of works have mapped learning (ie pedagogical concepts and methods) to elements of game design. In [12] an analytical model which maps learning mechanics to game mechanics is presented. The intention being that the serious game developer should start with the intended learning mechanism and develop a serious game based on the corresponding game mechanism. It is stated that the fundamental aspect of serious game design consists of the translation of learning goals and practices into mechanical elements of game-play. This approach is directly compatible with the paradigm we propose whereby the benefit delivery system is the key to development of the serious game.

In commercial game development, identifying and designing the core game-play mechanics (the *micro game loop*) is notoriously difficult and time-consuming [13]. The reason for this is that the sole purpose of the micro game loop is to provide fun to the player, a concept which is indefinable in terms of a foolproof method for providing it. Serious game development has a significant advantage here, as the core purpose of the game is apparent from the outset (i.e. the benefit that the game should provide to the user). A key concept in more recent paradigms for development of serious games is to match that benefit (learning outcome, behaviour change, etc) to a type of game-play.

III. Benefit Delivery System

Our paradigm for the development of serious games is based on the maxim that the purpose of a serious game is to deliver a specific benefit to the user. The exact nature of that benefit should already be apparent to the serious game developer (as it is, in fact, the *raison d'etre* of the project). The mechanism whereby the benefit is imbued to the user is the key concept from which the development of a serious game should stem. Consequently the benefit delivery mechanism (BDM) should be identified and defined at the start of development of any serious game.

TABLE I
THE FIVE CLASSES OF BENEFIT DELIVERY MECHANISM WITH EXAMPLE APPLICATIONS IN THE FIELDS OF HEALTH, EDUCATION AND COMMERCE

BDM	**Health examples**	**Education examples**	**Commercial examples**
Repetition	Rehabilitation of movement Behavioural change	Verbatim learning	Sports simulation Health and safety training
Exploration	Simulation of cause and effect	Independent discovery Guided discovery	Tourist information Issue awareness
Strategy	Cognitive ability Memory retention	Cognition training Understanding of process	Management simulation Financial simulation
Progress	Progression based therapies Assessment of condition	Trial and error Cumulative knowledge	Gamification Achievements and trophies
Social Interaction	Psychological assessment Social simulations	Team project training	Cooperation simulation Team building exercise

A. *Benefit Delivery Mechanisms*

We have identified five classes of benefit delivery mechanism which are applicable across all types of serious games for health. The classes are *repetition, exploration, strategy, progressive goal attainment* and *social interaction*. These classes are context agnostic and are purposefully broadly defined, to the extent that we believe they are relevant to all types of serious games. For each class we give examples for a broad range of applications to aid clarity.

1) Repetition: The benefit of a serious game is commonly provided through repeating the same action or sequence of tasks multiple times. This *repetition* class includes verbatim memorization of facts in an education game, rehabilitative exercise of an affected limb in a health game, health and safety training in the workplace, or exercising toward increased muscle memory in a sports training simulation.

2) Exploration: Encouraging the user to explore a topic is a common BDM for serious games where the benefit is accrued through the user's inquisitiveness and interest. Examples which use the *exploration* BDM are prevalent in education games based on discovery, and in games providing information on a topic or location, or raising awareness about an issue.

3) Strategy: Games which rely on the user choosing a strategy or a permutation of actions fall into this class of BDM. Strategies can range from the order that cards are played in well-known card games through to complex simulations where many elements are controlled independently to achieve an ultimate goal. Examples of games that use the *strategy* BDM include management simulations and games for assessment or rehabilitation of cognitive processes.

4) Progressive Goal Attainment: This is the central mechanism in a game system which involves a sequence of accumulative rewards for positive actions. In some cases there are also penalties for negative actions. The game is often structured so that the user is always striving to improve on their performance, by presenting a series of levels to which the player aspires. A form of high score table may also be conducive to further engagement. The *Progress* BDM is very common in so-called *gamification* schemes which often involve the award of badges, trophies, etc, sometimes attached to an avatar that is owned by the user. A game which is used to measure some aspect of the user's ability will often use this BDM, in order to assess progress of treatment, for example.

5) Social Interaction: A serious game may be built around the mechanism of social interaction. The rise of online and multi-player games has provided opportunities to incorporate multiple views and discussion into game scenarios, with applications in psychology as well as commercial concerns such as team-building.

Table I shows some examples of serious games applications in the fields of health, education and commerce classified by the type of BDM that is most appropriate. The examples are by no means exhaustive, but serve as an indicator of the breadth and diversity of serious game application that can be accommodated by the classification system.

B. *BDM as Key to Development of Serious Games*

The traditional "iron triangle" of software development shows that quality is achieved through balancing the three factors of *scope, resources* and *timescale*. These three factors are inevitably in conflict, so decisions must be made to integrate the perspective of one with another in order to best tailor development to a particular project (for example, if the timescale of a project must be curtailed, then either the scope must be reduced or the resources increased).

In our paradigm for the development of serious games as benefit delivery systems, we conflate the *timescale* factor with that of *resource*, but split up the *scope* factor to take account of the potentially conflicting factors of providing both fun game-play and a serious outcome.

The iron triangle for the design and development of serious games, as proposed by our paradigm, is illustrated in Figure 1. The three factors which must be taken into account, and balanced against one another, are *Resources, Benefit (serious)* and *Game (fun)*.

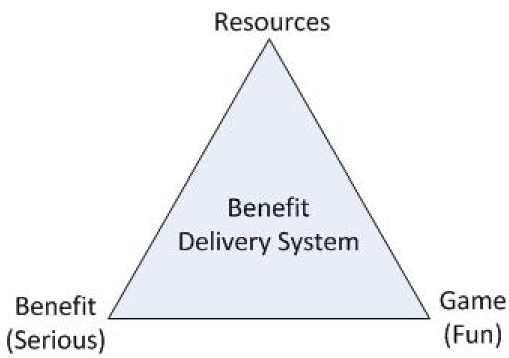

Fig. 1. The triangle of factors affecting design and development of a serious game.

1) Resources: Development must take place within a defined time-scale and budget. This factor affects the amount of time and number of developers that can be assigned to particular aspects of the project.

2) Benefit (Serious): The purpose of the serious game is to deliver some benefit either to the user or to the research project or practising professional. This factor affects decisions made in the design of the game to ensure that it complies with the intended outcome of the project and that the benefit is achieved.

3) Game (Fun): As the application is a game it should be fun and engaging to play. This factor affects the micro game loop, as well as the content of the game (setting, story, etc.), ensuring that the user is sufficiently engrossed while playing the game.

The iron triangle neatly encapsulates the apparent oxymoron in the term ”serious games”. When developing a serious game there is a constant danger of either concentrating on the serious aspect at the cost of the fun aspect (which may result in a game that is not sufficiently engaging, so the serious benefit is not conveyed due to lack of interest from the user), or focussing too much on the fun aspect while neglecting the serious aspect (so, while the user may engage with the game-play, there may be minimal serious benefit accrued from it). Both the *benefit* and *game* factors must also be balanced against the available resource for development of the application (in terms of both budget and time-scale).

Identification of the BDM for the serious game entails selecting an appropriate game-play mechanism which delivers the intended benefit through an established learning or behaviour-changing mechanism. Our paradigm states that early adoption of, and adhesion to, the benefit delivery mechanism informs the trade-off between the three corners of the iron triangle throughout development. This approach greatly improves the chances of delivering a serious game, in the form of a benefit delivery system, which utilises engaging game-play to achieve the intended benefit within the planned constraints of time and budget.

C. Process for Development of Benefit Delivery System

The process for development of a serious game as a benefit delivery system should start with clarity of what that benefit will be. Broadly speaking, the benefit will typically be some change in behaviour, knowledge or ability of the intended user. This can be thought of as the serious purpose of the application. An existing non-games mechanism is usually already known to the professionals in the serious field to which the game will be applied. Examples of these *serious mechanisms* include a pedagogical methodology, a training regime, or a medically prescribed set of behavioural changes. The next step in the process is key to the paradigm that is the topic of this paper. A game-play mechanism must be chosen which sufficiently emulates the serious mechanism within an interactive application. This is the *benefit delivery mechanic*.

Once the BDM is identified and agreed upon, the serious game can be designed and developed. All subsequent design and implementation decisions should be made in the context of providing support for the BDM. This includes the choice of platform for the game (laptop, tablet, console, etc), the input devices to be used (touch-screen, mouse, motion capture, etc), as well as the structure, content, feedback and reward scheme of the game.

Note that the process does not involve any advice on the setting, storyline or characters that comprise the context of the game. These elements are largely irrelevant to the benefit delivery mechanism, but serve as an enhancement of the attractiveness of playing the game, increasing the likelihood of user engagement.

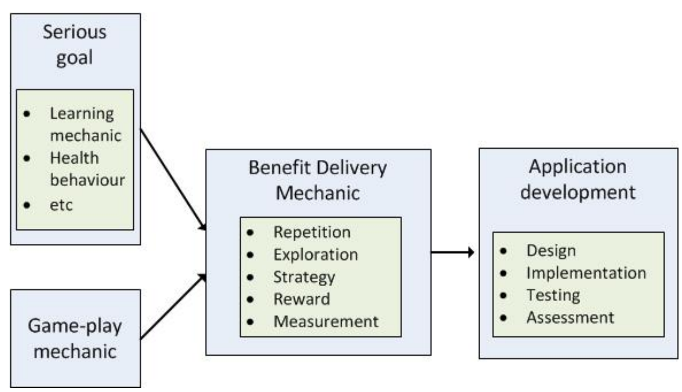

Fig. 2. The process for development of serious game as benefit delivery system. The benefit delivery mechanism is identified based on the desired serious outcome of the application and all subsequent development supports that mechanism.

The paradigm for considering a serious game as a benefit delivery system should be compatible with any existing software development process. The key to the approach is to identify the BDM for the application early in development and to base all further design and development decisions on that central mechanic. The flow chart in Figure 2 illustrates where the BDM fits into the development process.

It should be noted that the paradigm for development does not preclude or promote iterative development, or agile processes, which are increasingly common in software engineering and commercial games development [10]. The *application development* section of the process illustrated in Figure 2 may well consist of a development loop, whereby results of testing and feedback are fed back into the next iteration of the implementation phase. Indeed, under our paradigm, a significant aspect of testing should be an assessment of whether the game is continuing to support the identified BDM. If not, then some redesign and re-prioritisation of features, may be required.

Assessment of development tasks based on their relevance to, and support of, the BDM for the serious game should enhance clarity when prioritising the backlog of work for development of the project. In agile development, each sprint is planned around the highest priority tasks. The relevance of a task to the BDM should be incorporated into the calculation of the priority of tasks, ensuring that each sprint consists of work which serves to enhance the central purpose of the serious game.

The development paradigm should also be taken into account during the assessment and mitigation of risk for the project. An identified risk which may affect the successful implementation of the BDM may be considered as having a greater potential impact than a risk that does not affect the BDM. Mitigation of such risks should include an alternative plan which maintains the provision of the BDM. Again the adoption of our paradigm does not preclude or prescribe any particular approach to risk management, but it does provide an additional, and important, parameter to use in the assessment of risk.

Modern commercial game development generally includes fast prototyping of the micro game loop toward the start of the project [13]. This approach is intended to ensure that the game is built upon a central game-play mechanic which is enjoyable and satisfying (i.e. a playable demonstration is built using basic art assets so that the game-play can be iteratively honed before time and effort is committed to full production). The BDM of a serious game is an ideal candidate for fast prototyping. An early prototype demonstrating the mechanism for delivery of benefit can be used to fine tune the mechanic and to give confidence that the game idea is ready for full development.

D. Commercial Considerations

The adoption of our paradigm for development of serious games as benefit delivery systems has implications for commercial exploitation of serious games. So far we have considered the two corners of the iron triangle representing the "serious" and the "game" aspects of development, but the third corner (resource) also warrants discussion. This is the corner of the triangle most in line with commercial considerations of development (i.e. schedule and budget). To date, the majority of serious game development has been as part of a funded research project. As such the schedule, team size and budget tend to be rigidly defined within the terms of the funding. However, there is increasing interest in the commercial exploitation of serious games, initially in the form of gamification, but recently in wider application of serious games.

As has been described in previous sections, focussing development on the central mechanism for delivering the benefit of the serious game increases clarity in project planning, task prioritisation and risk management. This ought to lead to a more efficient and productive team and development process, increasing the chance of remaining within budget and schedule while maintaining quality.

In the authors' experience, the most common cause of commercial game development going over budget or over schedule is lack of clarity in the game design. This can lead to so-called "feature creep" where extra aspects of the game are introduced late in development, leaving significantly less time for the due processes of software engineering that are designed to ensure quality of product. It is our belief that adhesion to our development paradigm will alleviate the likelihood of this occurring. Focus on the BDM of the game, coupled with an early prototype of the BDM in action and ongoing consideration of the BDM in prioritisation of tasks, should contribute to a more efficient and focused development phase of the project.

It is also worth noting that the team working on a serious game is likely to consist of experts in diverse disciplines (professionals from the serious field of application, software engineers and game designers) [8]. Identifying the BDM for the serious game should focus discussion and therefore aid communications between the various disciplines.

IV. Case Studies

Three case studies of serious games for health are now considered. In each case we discuss the purpose of the serious game, and identify the benefit delivery mechanism which was utilised. The development of each serious game is then discussed in the context of how identifying the BDM informed implementation and design decisions.

A. Rehabilitative Game for Stroke: Repetition

"Circus Challenge" is a game developed for the rehabilitation of upper limb movement after stroke [14]. The application utilises a commodity motion capture device (Sixense) in a domestic environment. The user is encouraged to mimic the arm movement of the avatar (top centre of the screen in Figure 3) as it demonstrates the therapeutic movements which contribute to rehabilitation. The motion tracking equipment measures how well the user is performing the actions, and the circus characters react accordingly (successfully performing the movement leads to the characters achieving their aims and the score increasing). As the user meets the goals set by the application, further levels are unlocked allowing the user to progress through increasingly complex and challenging rehabilitative movements.

The benefit delivery mechanism is the *repetition* of moves ordered according to the therapist's requirements. Identifying this as the key mechanism of the game informed development

Fig. 3. Screenshot from stroke rehabilitation game "Circus Challenge" which utilises a commodity motion tracking device.

of all elements of the project. The user's understanding of the arm movements to be repeated was of paramount importance. Consequently the avatar which demonstrates the moves is front and centre in the screen, and its hands are colour coded against two coloured circles representing the current position of the user's hands (as detected by the motion tracking device). If the software determines that the user is struggling to match the movements of the avatar, instructional videos are automatically made available to the user through the graphical interface of the game. Identifying that the therapist should be able to offer any combination of moves was a key influence on designing the game as a sequence of discrete levels which can be ordered in any permutation through the use of a simple text file in a bespoke manner for each patient.

Identifying that the BDM involved repetition of only one specific rehabilitative move at any particular time greatly simplified development time and complexity. There are a large number of rehabilitative movements used in the game. Creating software which is capable of recognising any of the movements at any time would be time-consuming and processor intensive (the target hardware was relatively low-powered, as the application is to be used on laptops commonly available domestically). As the BDM required repetition of a single rehabilitative exercise during any specific level of the game, the complexity and processing requirements of the software could be greatly reduced. This decision, based on ensuring that all development supports the BDM, greatly reduced the cost and development time of the project.

B. Interactive Storybook for Cerebral Palsy: Exploration

"Jamie and Angus" is an interactive storybook for very young children suffering from cerebral palsy which affects the ability to move the hand, wrist and arm [15]. The game was developed for a smart tablet device. The front-facing camera is utilised to capture the motion of the child's hand. As the child explores the story-book there are opportunities to interact with the storybook content through hand gestures such as waves, grasps and pinches. These hand motions have been identified as those which are of rehabilitative use.

Fig. 4. Screenshot from children's interactive storybook game "Jamie and Angus" for young children suffering from cerebral palsy.

The benefit delivery mechanism is the *exploration* of the interactive storybook as the child is encouraged to experiment with the storybook to reveal hidden content (as can be seen in Figure 4). Early in development it was identified that this exploration of content could best be achieved through the storybook format. A tablet was chosen as the development platform as it best allowed the storybook to be read in conjunction with an adult (i.e. the child sits on the adult's knee and the exploration is somewhat guided by the adult as well as the storybook itself).

C. Game for Severe Paralysis of the Upper Limb: Progress

The "spaceship" game is aimed at patients with severe paralysis of the upper limb [16]. The intended user of this application may only be capable of minimal movement and application of pressure with the affected limb. A force-feedback joystick was used as the input device. The user is tasked with applying force on the joystick in particular directions for specified amounts of time, causing the spaceship to hover over targets on the screen and therefore avoid obstacles. Figure 5 illustrates the game in play.

Fig. 5. Screenshot from spaceship game for patients with severe paralysis of upper limb.

The application was developed with the purpose of assessing the movement capability of the user, so the benefit delivery mechanism is one of *progress* of the pressure that the user can apply with the paretic limb. Identification of this mechanism as the driving force of the project led to decisions on the content of the game and especially the device to be used. The force feedback joystick has a high fidelity of input, allowing the application to measure the small pressures that the intended user is capable of applying. The on-screen interface is also designed to support the BDM, with the target position for the joystick, and the current position, clearly marked and differentiated, so that the direction that the user should apply pressure to the joystick is clear.

The three case studies have been chosen to demonstrate that serious games which are within the same broad application field (health) can have markedly different mechanisms for delivering the health related benefit. In each case we have described how early identification of the BDM informed decisions on aspects of the project as diverse as the hardware platform, the structure of the game, and the specific features that were implemented.

D. Recommendations

We now present a series of recommendations for development of serious games as benefit delivery systems based on our experience with the case study projects. It is the authors' intent that these recommendations should inform development of serious games in all application fields in the future.

The paper has described a paradigm for focusing the development of serious games on the mechanism that is adopted for delivering the benefit of the application to the user. The advantages of taking this approach have been described in some detail in previous sections. In this section we will address some specific areas of serious game development, and comment on the pertinence of the paradigm to each area.

1) Micro Game Loop: The micro game loop is the term used to describe the actions that the player is carrying out from one second to the next in the game (for example steering a car, jumping obstacles, choosing playing cards). Our paradigm states that the micro game loop should be the mechanism for delivery of the benefit. It is likely that the micro game loop simulates the serious mechanism for transferring benefit, which is likely to be well known to the professionals in the serious filed of application.

2) Game Genre: The commercial games sector produces many genres of game (puzzle, platform, first person shooter, role playing, etc). Our paradigm recommends that the choice of genre for a serious game should support the BDM. For example a racing game is unlikely to support the *exploration* BDM but may well support the *progress* BDM.

3) Hardware platform: The choice of platform on which to run the serious game must be made early in development. The BDM should inform this decision. The case study of the interactive storybook demonstrates that the smart tablet platform was most appropriate for the exploration BDM of that project.

4) Input Device: There are many diverse devices available for input to serious games (touch screen, mouse, joystick, motion capture device). This decision is a central one for any serious game and it should support the BDM. In effect the choice is based on what the user will actually be doing to access the BDM. All three case studies show how the BDM heavily influenced the choice of input device.

5) Feedback to Player: This aspect completes the loop that implements the BDM (input device drives the game-play, which drives the feedback, which the player reacts to with the input device). As with the input device, this aspect is crucial to the success of a serious game and should be designed to focus the game and the player on the BDM.

6) Game context - story, setting characters: The context for the serious game is largely independent of the BDM. A particular serious game mechanism could be applied just as well to a circus setting as a pirate theme. Adhesion to the paradigm would deter the serious game developer from spending too much time and effort on context-related elements of the game which do not directly support the BDM.

7) Data Storage: Many serious games record and store data from their usage, either locally or uploaded to the cloud. While the BDM is unlikely to directly affect the manner in which data is recorded, it is worth noting that, if the specific parameters being recorded are not directly related to the BDM, then that may be an indication that an inappropriate BDM has been chosen.

V. Conclusions

The mechanism whereby a benefit is transferred to the user has been identified in this paper as the core concept for the design and development of a serious game. Indeed we would argue that the interactive nature of the mechanism for benefit delivery is the reason why a serious game is employed in preference to a non-games related solution. A paradigm for development of serious games as benefit delivery systems has been described, based on this maxim. Serious games have been successfully applied across a multitude of fields including, but not limited to, health, education and commerce. The attraction of utilising serious games is intuitive: a user is more likely to engage with the mechanism for delivering some benefit to them if it is presented in the form of an interactive and enjoyable experience. We argue that the identification of this mechanism is key to successful application of a serious game, and have presented the first paradigm for development of serious games to be based on that key mechanism for benefit delivery.

In this paper we have explained the reasoning which led us to the paradigm for development of serious games as benefit delivery systems. A classification system for serious games, based on the benefit delivery mechanism was introduced, and the five classes of *repetition, exploration, strategy, progressive goal attainment* and *social interaction* have been identified. Example applications for all five classes have been listed in the fields of health, education and commerce. The classifications are purposefully broadly defined, so that the taxonomy is applicable across all application fields and genres of serious games. We have also described three case studies, in the context of their benefit delivery mechanism. In each case, early identification of the most relevant BDM clarified design choices and informed development in terms of both serious application and software engineering. Specific decisions for each case study, stemming from the maxim that all development should support the BDM, have been described.

Existing taxonomies for serious games have tended to concentrate either on the field of study to which the game is applied (e.g. health, education, etc.), or the genre of game that has been utilised (e.g. puzzle, platform, motion capture, etc.). We argue that the key feature of a serious game is the mechanism that is used to convey the benefit. This paradigm supports commonality of approach across widely different application fields. At the outset of a serious game development project, a mechanism for conveying the benefit is usually apparent from the application field (e.g. a pedagogic methodology, or a persuasive mechanism for behavioural change for health). Our paradigm states that the choice of game-play mechanic is of paramount importance in delivering the benefit through the intended process. The combination of serious mechanic and gameplay mechanic is the benefit delivery mechanic. All subsequent development of the project should support the identified BDM.

It is hoped that the paradigm presented in this paper will inform future developments in serious games for health, education and commerce. In particular, adherence to the concept that the serious game's purpose is as a benefit delivery system, and that the key mechanism is that which delivers the benefit to the user, should ensure a focussed, efficient and successful development process for serious games.

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