Towards a trans-disciplinary methodology for a game-based intervention development process

Arnab, S & Clarke, S

Original citation & hyperlink:
Arnab, S & Clarke, S 2017, 'Towards a trans-disciplinary methodology for a game-based intervention development process' *British Journal of Educational Technology*, vol 48, no. 2, pp. 279-312
https://dx.doi.org/10.1111/bjet.12377

DOI 10.1111/bjet.12377
ISSN 0007-1013
ESSN 1467-8535

Publisher: Wiley

Towards a trans-disciplinary methodology for a game-based intervention development process

Sylvester Arnab
Disruptive Media Learning Lab, Coventry University, CV1 5FB, UK
s.arnab@coventry.ac.uk

Samantha Clarke
ab4588@coventry.ac.uk
Serious Games Institute, Coventry University, CV1 5FB, UK

Abstract

The application of game-based learning adds play into educational and instructional contexts. Even though there is a lacking of standard methodologies or formulaic frameworks to better inform game-based intervention development, there exist scientific and empirical studies that can serve as benchmarks for establishing the scientific validity in terms of the efficacy of using games to achieve serious outcomes. The development of these games does not normally follow a specific set of guidelines, which limits replication. There is a need to reflect on such a multi-disciplinary process and infuse knowledge from relevant disciplines towards developing a unity of considerations and approaches beyond the disciplinary perspectives. An infused and trans-disciplinary methodological framework could serve as a guideline to inform the development process of a game-based approach. With these perspectives, this paper aims to provide an example of how relevant theories and frameworks can be adopted collectively in order to inform a development process. Based on a digital game intervention aiming to support the delivery of Relationships and Sex Education (RSE) in the UK, this paper reflects on trans-disciplinary considerations, informed by frameworks such as the Four-Dimensional Framework (4DF), the Intervention Mapping (IM) approach, Mechanics Dynamics Aesthetics model (MDA) and Learning Mechanics-Game Mechanics (LM-GM) mapping. IM when infused with the game design considerations of 4DF provides a more procedural perspective to game-based intervention development, collectively reflecting a participatory development approach. This subsequently provides the basis upon which other theoretical and methodological frameworks can be embedded, such as the MDA and the LM-GM models in order to marry the pedagogical aspects with the entertainment attributes of gameplay. These components when integrated may formulate a trans-disciplinary model that can be adopted and adapted by other researchers, designers and developers.

Keywords: *serious games, game design, trans-disciplinary, game-based learning, game development life cycle*

Introduction

The increasing use of games in non-entertainment contexts, also known as Serious Games (SG) is transforming everyday lives and most importantly injecting more fun in everyday contexts (McGonigal, 2008). The power of games to immerse and motivate (Garris, Ahlers and Driskell, 2002; Rooney, 2012; Arnab et al., 2013) and the capabilities of games to foster and facilitate cognitive gain, awareness, and behavioural change have encouraged more games of this nature to be developed within a research context as well as to be deployed in real application settings.

Despite significant challenges for researchers in the SG field in terms of the lack of standard methodologies or formulaic frameworks that guarantee success and efficacy, there are some empirical studies that can serve as benchmarks for establishing scientific validity for the efficacy of using games to motivate learning and achieve learning outcomes. The development of these games does not

normally follow a specific set of guidelines or process, which makes them more bespoke and less replicable. Moreover, existing frameworks or guidelines are often high-level and/or theoretical design models that provide general design considerations rather than a prescribed development process. Rooney (2012) suggested that developing guidelines for integrating relevant components in serious games would be a useful addition to the existing design literatures and frameworks.

A SG is more than just a game software. The design and development process of a SG has to be rigorous as the desired and expected impact of a SG includes facilitating learning outcomes, attitudinal change and/or behaviour nurturing. Thou the general development process mirrors a software development lifecycle, the approach is highly multi-disciplinary. Multidisciplinary approach refers to drawing on knowledge from different disciplines but generally stays within the disciplinary boundaries. In order to promote a more holistic approach, there is a need for multi-disciplinary considerations and process to be translated and correlated into a trans-disciplinary development methodology, infusing knowledge from different disciplines and creating a unity of intellectual frameworks/models/considerations beyond one specific disciplinary perspective.

In this paper, we define a trans-disciplinary model for SG development as a strategy or methodology that crosses many disciplinary boundaries to create a holistic approach. Even though, a development team should ideally consist of all relevant disciplines, in reality the team would have to rely on limited resources. A more correlated methodological model derived from a trans-dsiciplinary process could thus act as a guide to inform development considerations and process.

Inspired by a design case approach to aid the understanding of a trans-disciplinary development process of a SG, this paper reflects and discusses how elements from several existing discipline-specific frameworks can be infused to form a collective approach. A design case is a description of a real artefact or experience, where they are not validation studies, but can be carried out as a summative discourse of the process and principle upon which the design was based (Boling, 2010). As a test case, we will reflect on the development of a game-based intervention aiming to scaffold teaching and learning of sensitive issues within the context of Relationships and Sex Education (RSE) in the UK. The game has been trialled and outcomes are extensively discussed in Arnab et al. (2013).

This paper will reflect on the considerations leading to an understanding of the trans-disciplinary perspectives of the development process. We will thus discuss the adopted theories and frameworks from the domain of serious games, health intervention, entertainment games and pedagogy that have collectively informed the process, which include:

- Four-Dimensional Framework (4DF) (de Freitas & Jarvis 2008)- commonly used to inform considerations for serious games evaluation and design,
- Intervention Mapping (IM) approach (Batholomew et al. 2011)- a methodology that guides the design, implementation and evaluation of health intervention programmes,
- Mechanics Dynamics Aesthetics model (MDA) (Hunnicke et al. 2004)- a framework that acts as a guideline for entertainment game design, and
- Learning Mechanics-Game Mechanics (LM-GM) mapping (Lim et al. 2013, Arnab et al. 2015) – the mapping of pedagogical aspects to game mechanics.

The remainder of the paper is organised as follows. The next section presents an overview of SG design and development. In order to provide the context for the discussion and reflection of trans-disciplinary considerations, the following section introduces the PR:EPARe game as a test case, the

description of the four frameworks and models that influenced its design and development, and concluded with the trial outcomes. The paper continues with a discussion on the transdiciplinary perspective of the process leading to an infused model and methodology arising from the design and development experience. Finally, the conclusion section summarises the paper and sketches directions for future research.

Serious games design and development: Models and frameworks

While there is a consensus on the instructional potential of SG, Arnab et al. (2015) argued that there is still a lack of methodologies and tools not only for design but also for analysis and evaluation. The development process or lifecycle has to be supported from the user requirements through to the deployment and evaluations. By learning from existing development processes that lead to successful deployment and evaluation of SG, a more integrated process can be used as a guideline for the development of other games.

Rooney (2012) explored a triadic theoretical framework for SG design, comprising the elements of play, pedagogy and fidelity and he found that it is clear that due to the inherent incongruities between game design (entertainment), simulation design (fidelity), and pedagogy (education), difficulties persist in balancing these elements during the design process and infusing these elements into one coherent theoretical framework is indeed a challenge. This is further complicated by the inherent multidisciplinary nature of SG design. While it frequently entails collaboration among multiple team members from different disciplines (for example technical versus pedagogic), conflicting interests, perspectives and priorities of designers from different backgrounds can also complicate the "balancing" process (Pulman & Shufflebottom, 2009; Rooney, 2012).

Huynh-Kim-Bang et al. (2011) suggest that the principles of learning and playing can be conflicting and infusing the two is a major challenge for serious games design. Design models, such as the RETAIN model (Gunter et al. 2007) evaluates the role of academic content incorporated in a SG in promoting transfer of knowledge by infusing three learning theories, namely Keller's ARCS Model, Gagne's Events of Instruction and Piaget's ideas on schema. de Freitas and Oliver's 4DF model is more generic where it focuses on four aspects when designing and evaluating a SG, namely Context, Learners, Pedagogy and Representation. These aspects reflect the dimensions to be considered in a user-centred software development process; advocating requirement analysis to set the context, participatory approach to address the needs for intervention and of the learners, pedagogical perspectives to inform the instructional design of the game, and game design software and hardware specifications to represent the context and requirements.

Arnab et al. (2015) highlighted that the lack of robust methodology that informs the correlation between mechanics related to learning and playing means that it is difficult for efficacy and success to be guaranteed. Synthesising, while the existing practices, frameworks and models in SG design appear to take SG mechanics into consideration, '*they do not specifically target the analysis of the relationships between game mechanics and learning constructs, which is a key factor in game design for learning'*. (Arnab et al. 2015, page 394). Models, such as the Magic Bullet (Becker, 2011) monitors the way a game manages the player's learning and it classifies learning in four categories, and the SG Design Assessment (SGDA) model (Mitgutsch & Alvarado, 2012) focuses on the coherence of a game's purpose in relation to the other design elements. Amory's Game Object Model (GOM) aims to support educational games development based around the notion of interrelated components (Amory, 2007). Its high level operatives however mean that *GOM 'does not sufficiently support a description of a Serious Game's learning aspects and their relationships with game*

components'. Responding to the challenge in defining these relationships, Lim et al (2013) proposed the LM-GM model intended for aiding the design and analysis of a game-based learning approach and this is a key state-of-the-art in initiatives related to the definition of SG Mechanics (Arnab et al. 2015). These models do not cater for presenting formulaic strategies or methodologies for a development process but key to understanding the relationships between game design and the desired learning content and outcomes. There is thus a need for considerations and processes from the relevant models and disciplines to be correlated based on existing development cases towards defining a methodological process and guidelines that can ease adoption by other designers and developers.

The PR:EPARe game: A game-based intervention for supporting Relationships and Sex Education (RSE) delivery

This section introduces a SG and its development process as a test case to illustrate how considerations, models and frameworks from different disciplines can be adopted, providing the context for the discussion on the trans-disciplinary perspectives in the paper.

Background

Delivery of high quality and effective RSE is a challenging task, and one, which necessitates complex inquiry into various dimensions including intervention needs, ethics, role of teachers and characteristics of the target student population. Ensuring adolescents are equipped with the necessary skills to handle coercion and pressure from peers for instance is a central component of effective relationship education (Clarke et al. 2012). Clarke et al. (2012) and Arnab et al. (2013) emphasised that support for facilitating discourse on sensitive issues within a classroom setting is often overlooked, with many teachers receiving little or no training in this area, resulting in concerns of inadequate knowledge surrounding this discipline (Ryan & Dunn 1979).

Currently, effective RSE as outlined in the Department for Education and Employment (2000) guidance report, emphasises the requirement to establish and support young people through their exploration of sexual development. Referring to the National Healthy School Standard framework (1999), the report concludes that schools developing best practise in their curriculum, should look to include content that covers the physical, emotional and moral aspects of RSE in order to provide a comprehensive syllabus. In short, a balanced syllabus that is inclusive and explores the theory and practical subject matter that promotes critical thinking and encourages students to engage in informed choices when presented with personal or social situations.

Although educational institutions are offered guidance as to the content that should be offered, the design structure and delivery remains at the discretion of the individual school. The Department of Education website provides the information that generally, academies and Free Schools are required to provide a broad and balanced curriculum to include English, maths and science and to make provision for the teaching of religious education. Beyond this they have the freedom to design a curriculum which meets their pupils' needs, aspirations and interests. Whilst this provides a flexibility to design a relevant curriculum to support specific needs relevant to the institution, for example, religious or cultural establishments, inevitable deficiencies in certain subject matters are likely to be apparent.

Focus of the educational syllabus has often drawn away from the emotional context of relationships within sex education, with young people commenting on the absence of any meaningful and practical relationship advice (Education Act 1996). A more recent survey conducted by CHSS (Billings et al.

2007) on the current state of sexual health education and services in Kent, reported that respondents perceived obtaining a greater level of instruction in physiological aspects of RSE in favour of psychological and emotional guidance. Although several years after the DfEE report (2000), attitudes to discourse of emotions and relationship guidance seem to have remained comparable with a strong emphasis on the physical implications of un-safe sex. These findings highlight a need for schools to re-assess their commitment to the RSE curriculum content, in order to include a broader range of emotional contexts that young people and adolescents can engage with. A re-assessment of the curriculum as outlined on the Department of Education's website (2000) now demonstrates that health and sex education is to fall under the title of Personal, social, health and economic education (PSHEE). Whilst this allows coverage of several areas previously considered low priority or un-suitable topics, training in the subject material and delivery methods are required in order to create PSHEE lessons that present high impact guidance for young people.

A game-based approach

To address this issue, a digital game aptly named PR:EPARe (Positive Relationships: Eliminating Coercion and Pressure in Adolescent Relationships) was developed, trialled and evaluated to support the schools in Coventry and Warwickshire, UK. The process by which this game was developed provides insights into the trans-disciplinary approach in designing and developing the intervention.

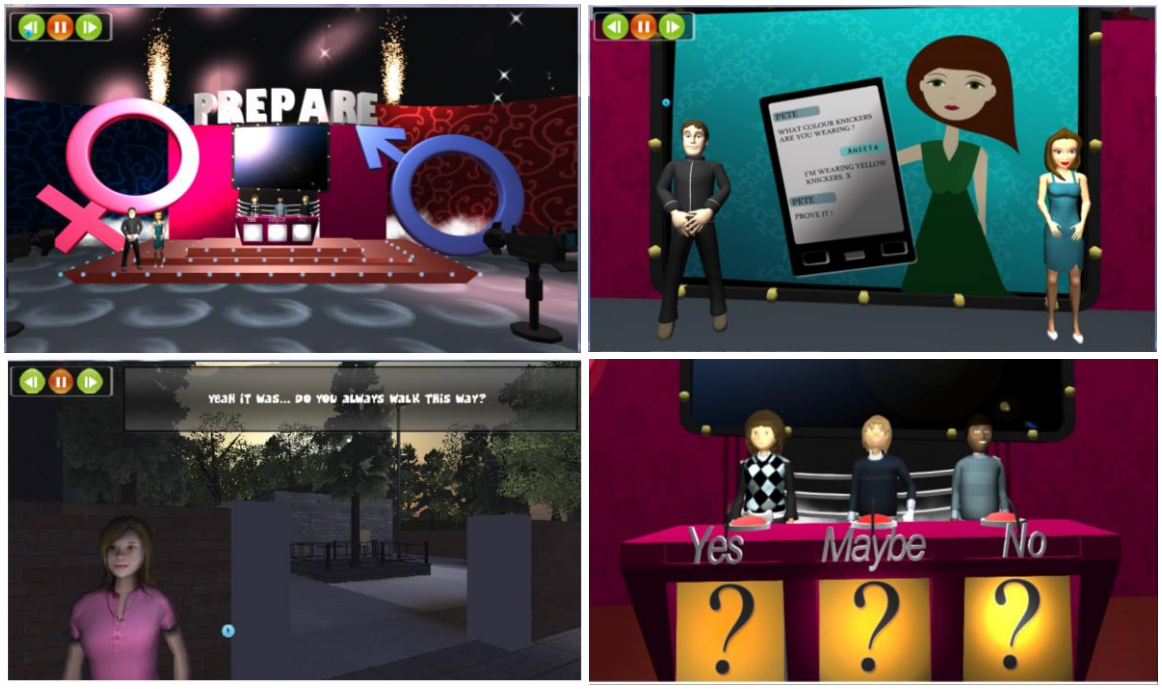

Figure 1. Screenshots of the Game-Show themed PR:EPARe game (Arnab et al. 2013)

The final game adopted a 'Game Show' concept (Figure 1) and the dynamic of the game interaction involves: (i) group participation on the correct response to the 'questions and answers' round, where six scenarios on potential coercive behaviour are narrated by the game show host, and (ii) the 'Role-Playing' round, where as a group, the students will play a role in two scenarios with the opportunity to be the coerced and the coercer. Throughout the game, the mechanics and dynamics include the option for the teacher to 'pause' game play, allowing time for communal discovery and discourse on the issues represented by the game scenarios. To promote communal responsibility and encourage practical thinking in the role-playing round, editable text boxes are provided to allow the pupils and

the teacher to decide on a mutually agreeable response for avoiding coercion, aiming to promote positive participation and discourse from all class members.

Disciplinary-specific model considerations

Prior to reflecting on the design and development considerations that lead to the PR:EPARe game, this sub-section describes the models and frameworks that were adopted. The frameworks cover domains including serious games, health intervention, entertainment games and pedagogy.

Four-Dimensional Framework (4DF)

4DF proposes to inform game design by referring to four discrete dimensions: (i) the Context within which learning takes place (e.g. disciplinary context, blended or standalone, place of learning, formal or informal), (ii) Learner profiling (e.g. demography, ICT skills, gaming experience), (iii) selection of Pedagogies used (e.g. learning methods, models and mechanics) and (iv) mode of representation (e.g. game concepts, game mechanics, game engines, mode of deployment, level of fidelity, interactivity). 4DF is not a methodology that structures a design and development process. However, collective consideration of the individual dimension aims to contribute towards the design of successful game-based learning experiences (de Freitas and Jarvis 2008).

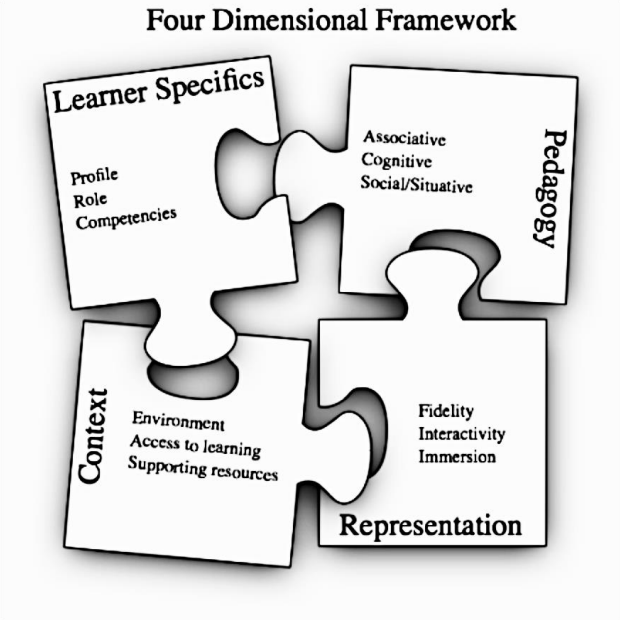

Figure 2. 4DF dimensions

By following the 4DF model, game developers should be able to deconstruct SG design into key components by taking into account the characteristics of learners and the different pedagogical and contextual constraints to enact effective absorption, promote reflection on knowledge and transfer these learning variables into real-world scenarios. Deployment choices are very important adhering to the context dimension. In terms of RSE, a formal setting is a requirement and a blended approach is a solution that may support delivery of the RSE programme taking into account the role of a teacher and the exploratory nature of the learning process (Clarke et al. 2012). This approach thus encourages pedagogical selection in light of existing constraints in the remaining dimensions, an important exercise in early-stage design (Clarke et al. 2012). However, 4DF is not a procedure and it also does not provide concrete mapping of the relationships between the selected pedagogies and game mechanics within the representation dimension, which would necessitate considerations of additional sources to fill in the gap.

Intervention Mapping approach (IM)

RSE programmes fall under health education addressing issues concerning relationships including a sexual one that would require educational interventions to be rigorously and ethically developed and evaluated. To ensure that methodologies and tools used to design a game-based intervention are facilitated with such a rigour, IM (Bartholomew et al. 2011) can be adopted. IM is a logical planning framework in which the needs and requirements of stakeholders are considered against clinical evidence to provide an application that is both evidence and theory based.

IM consists of six planning stages that carry an iterative approach throughout, generating design requirements and specifications to inform the design, implementation and evaluation of an intervention programme. It uses structured and detailed planning to ensure that the resulting intervention is grounded in the needs of the intended audience, informed by theory and evidence, and sensitive to the organisational, environmental, and cultural climate in which it will be embedded. It uses a logical process involving a series of sequential and iterative steps. These steps are illustrated in figure 3.

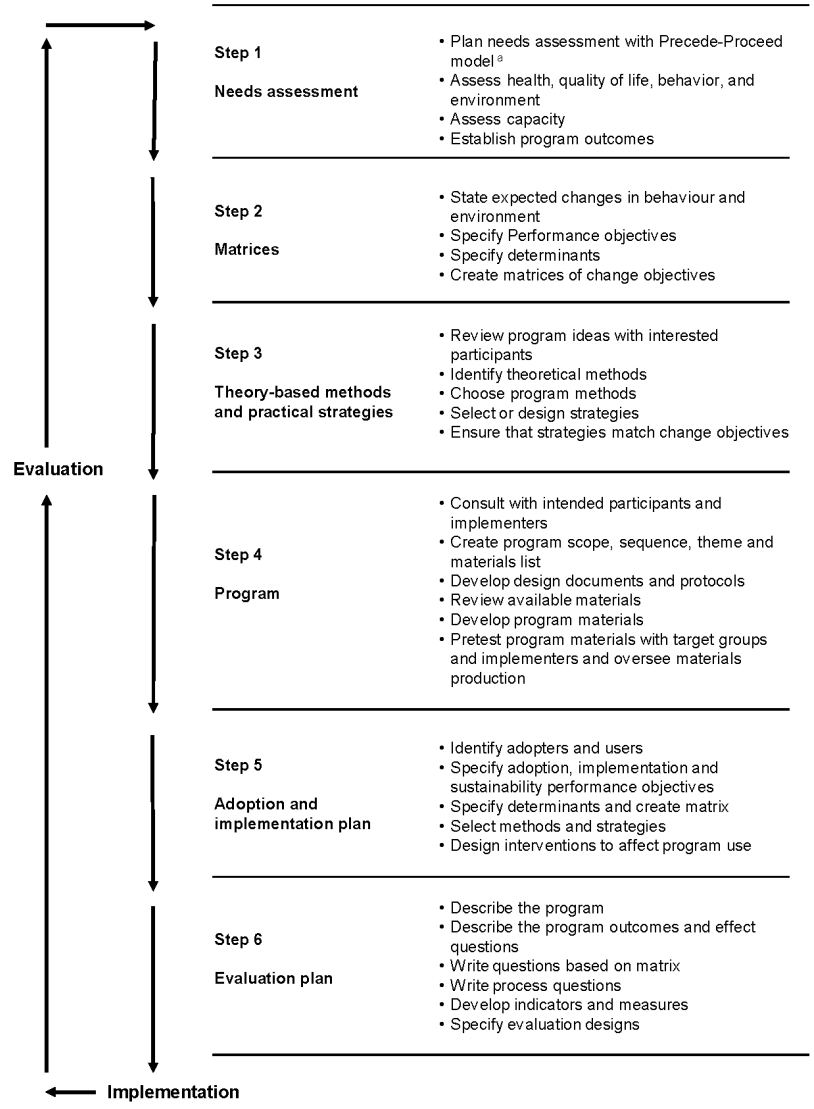

Figure 3. Bartholomew's Intervention Mapping Framework

IM when infused with the design considerations of 4DF provides a more procedural perspective to game-based intervention design, subsequently providing the basis upon which other theoretical and methodological frameworks can be embedded, such as MDA and LM-GM.

Mechanics Dynamics Aesthetics (MDA)

Before serious outcomes can be fostered in SG, the game itself has to be entertaining in order to motivate and sustain engagement. The MDA model (Hunicke et al. 2004) proposes a methodology for understanding games design, bridging the gap between game developers and player experience. Based on the perspectives that iterative design process optimises the quality of a final design and that analysis is essential for determining the overall significant impact imparted to players, Hunnicke et al. (2004) offers the MDA model as a production tool to aid understanding, providing a coherent approach to a game development cycle. An analysis of unit tests and game critics is considered essential to inform and support the iterative cycle of development, leading to a refined end design.

MDA formalises a game into three components, namely (i) rules, (ii) system and (iii) fun; translated into their respective design equivalence: Mechanics, Dynamics and Aesthetics (Figure 4).

Figure 4. MDA Component Relationships, and Designer and Player Relationship (Hunicke et al. 2004)

From this deconstructed point of view, these diagrams represent the fundamental structure of a game presented in the MDA and the overall relationship process between the structure, designer and player. These components are broken down further (Hunicke et al. 2004) as follows:

- Mechanics – particular game components, at the level of data representation and algorithms.
- Dynamics - run-time behaviour of the mechanics acting on player inputs and each other's outputs over time.
- Aesthetics - desirable emotional responses evoked in the player, when he/she interacts with the game system.

MDA is an important model to inform game design considerations required within the 'representation' dimension of 4DF, for instance to ensure that play characteristics match the target audience/learners.

Learning Mechanics-Game Mechanics (LM-GM) mapping

To map pedagogical constructs to entertaining gameplay, Lim et al (2013) proposed the LM-GM and was evaluated by Arnab et al. (2015) as a SG analysis guideline with positive outcomes. As a general overview, the pedagogical elements are viewed as an abstract interface while game elements are deemed as a concrete interface of SGs. This means that pedagogy and its methods are abstract (theoretical and conceptual), while game mechanics are concrete, i.e. by rules or algorithms.

Figure 5 lists an example of the learning mechanics (LMs) and the game mechanics (GMs). The mechanics that support both learning and games are regarded as abstract or concrete depending on the mode of operation, where the abstract elements are more conceptual and the concrete counterparts are more explicit and implementable. The concrete mechanisms enable abstract concepts to work. The model is however descriptive and not prescriptive, '*in the sense that it allows its users to freely relate*

learning and gaming mechanics to describe SG situations by drawing a map and filling a table' (Arnab et al. 2015, page 396).

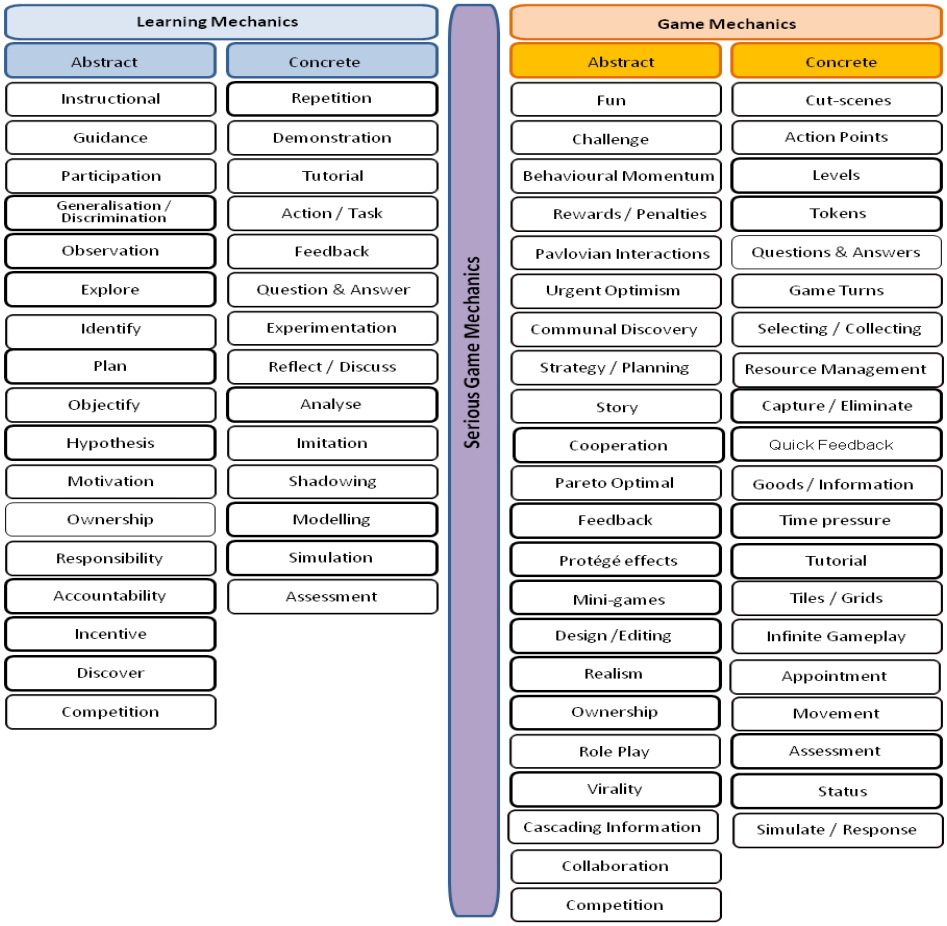

Figure 5. The LM-GM mapping framework (Arnab et al. 2015)

LM-GM can be used to either aid SG design or game analysis, where it provides a concise means to map how ludic elements link to pedagogy intent directly based on a player's actions and game play, i.e. SG mechanics. The model is also included as an important component towards informing the design of stealth assessment via a SG within an intelligent scaffolding infrastructure (Baalsrud Hauge et al. 2015).

With regards to the 4DF dimensions, learning is influenced by the context, pedagogy and learner profiling. Using this model, gameplay design takes into account the learning mechanics relevant for the objectives of a learning context.

Reflections of Models Influence on Game Development

The development of the PR:EPARe game involved a significant amount of analysis, design and feedback strategy meetings between each of the project's development units. These teams included clinical psychologists, researchers, focus groups, game developers, game programmers, sexual health practitioners and end users. Additionally, six stakeholder groups, Applied Research Centre in Health & Lifestyle Interventions, NHS Coventry Public health, NHS Warwickshire Public health, Coventry City Council, Warwickshire County Council and the Serious Games Institute were engaged to help inform this process.

These stakeholders were used to gather data and thus guide the development of the PR:EPARe game, sharing information and providing instruction for the initial concept meeting and providing feedback throughout the project. These groups also helped recruiting potential young person groups that could participate in the evaluation phase. Whilst there are varying approaches to assist with overcoming issues of interrelationship development, perhaps one of the most extensive techniques that developers can apply is the adoption of participatory research and design when creating SG. Participatory design is a method that actively encourages the involvement of all project stakeholders such as practitioners, developers, researchers, end-users, educationalists and all other members of the research program. In effect it creates a multi-disciplinary team, whose opinions and ideas inform the design and development process to create a product that is further centred on user requirements and usability (Schuler and Namioka 1993).

This section presents some of the main reflections of the strategies and methods that were taken from the IM, 4DF, MDA and LM-GM models in order to inform the design and development of the game PR:EPARe.

IM needs Analysis, LM-GM and MDA aesthetics table

The four methods suggest that to promote engagement in users, user specification and user experience need to play a considerable role in the design and development of a product. The IM and 4DF have dedicated sections to the consideration of user studies, with the IM approach supporting a needs analysis section and the 4DF supporting a learner specification approach. These approaches show commonalities in attempting to support the user by providing a tailored guide for the e-learning experience. Adopting these approaches, information can be gathered on the profile of the target user group such as age, gender, competencies and behavioural factors, which are used to aid in the development process. Obtaining this information early can lead to informed choices in usability design further allowing developers to consider the needs of the target user groups.

A needs analysis from the IM method was used in the PR:EPARe project to gather data on target user groups. Steering groups were used to gather evidence to support the subject matter and focus groups were conducted to indicate end users needs and desires of a serious game. Focusing on evidence provided from the steering groups, comparisons were drawn through reoccurring themes set out by the development team. One such theme from user feedback indicated that users preffered an element of competition to a game. Other themes to arise were that users mentioned *'The Sims'* game, with the mechanic of playing out a character life, and experiencing different roles. Adopting this feedback, the MDA and LM-GM models were used to form matching player experiences or 'aesthetics' against relevant learning mechanics to ensure that the game provided a player led experience, promoting acceptance and engagement. Examining the aesthetics table, four core representations were chosen to model the game experience around based upon the feedback gathered from the needs analysis.

- Challenge – Game as obstacle course
- Discovery – Game as uncharted territory
- Fantasy – Game as make believe
- Expression – Game as self-discovery

These experiences were drawn into the games design in order to create an engaging user experience, with section one of the game highlighting challenge and discovery and section two emphasising the fantasy and expression experiences. Shown below in Table 1, the game aesthetics were matched

against corresponding learning mechanics taken from the LM-GM model to formulate a foundation of the games design needs.

Table 1. Aesthetics to learning mechanics mapping

Aesthetic	Learning Mechanics
Challenge	Competition – Action/task
Discovery	Discover - Experimentation
Fantasy	Participation - Simulation
Expression	Identify – Reflect/Discuss

User Analysis and End User Mechanics

To follow on the importance of learner/user profiling for game acceptance and engagement as outlined in the IM, MDA & LM-GM, the needs analysis report was further analysed to highlight additional considerations. The feedback indicated the importance of developing facilitator motivation and engagement alongside that of the learner. The deployment and delivery of an effective serious game required that a practitioner leading the RSE lesson perceive that the game was altogether useful and uncomplicated to use in a classroom environment. To address this, planning for two end user experiences that included both student and practitioner led design were undertaken.

Using the steering group's feedback from the IM needs analysis, focus on recommendations of the games content were developed to coincide and complement the existing RSE curriculum. It was also raised that focus to be drawn on relationship building education, sexual and non-sexual, and was highlighted as a gap in the current curriculum. Using this approach, the development team could determine what practitioners were likely to perceive as useful in their RSE lesson development. This was fed into the overall programme goal and concept development of PR:EPARe.

To develop PR:EPARe from a practitioner-led user view, considerations of the 4DF and the IM models, which showed evidence to support development of context and practical assessment strategies provided aid needed in this area. Feedback conducted as to the educational circumstances such as game content, environment, class structure, resources, support and technology indicated that practitioners need to feel in control and comfortable using a game in class. To address this, a combination of methods was used in view of practitioner user design, game dynamics and mechanics, game technology and the supporting practitioner handbook.

Aesthetics of the game were chosen specifically to foster student user acceptance and the dynamics of the game were determined from the MDA approach to provide the run time behaviour of the player inputs. This was used as a basis for instilling practitioner based design into the game, insuring that the practitioner had complete control of the games behavioural aspects through the student's input. Game mechanics were instilled to support practitioner control and review.

The 4DF dimensions draws a direct emphasis on technological considerations when developing a serious game. This was taken into account when considering practitioner acceptance and led to the game's technical specifications being able to run alongside existing school acquired technology such as Smart Boards, PCs and Macs. To foster acceptance, links to current school technology within the PR:EPARe game were developed in an attempt to promote ease of use.

Additionally, a facilitator's manual was created to aid practitioner support in the delivery of PR:EPARe. The 4DF model asserts that it is necessary to provide adequate resources to aid a serious game. This is further backed up in step 5 of the IM approach: the adoption and implementation plan, that supporting resources and strategies are incorporated to aid behaviour change. Whilst the behaviour change at this point is not of the students, it is important that the facilitator feel comfortable and supported, even if adverse to technological applications.

End User Involvement

A core requirement from the IM needs analysis was that PR:EPARe include both individual and group styles of play to fit into the classroom environment. To address this, the developers incorporated game mechanics and learning mechanics that were chosen to aid and encourage the users to interact with the game environment. Building on the development of the MDAs aesthetic selections and LM-GM learning mechanics chosen for PR:EPARe, game mechanics were chosen to compliment both styles of play. For example; the aesthetic choice to include a competitive element in the game play relied on the desire of the players to interact with the game. A reward structure was therefore set in place to offer both positive and negative reinforcement for answers given by the players. The reward structure set out as a mechanic inspired from the MDA model, allows for a dynamic behaviour to occur between the players. By encouraging player consequence through the competitive element, players have a vested interest in how they interact with the game play. This tactic was used encourage interest in both group and individual play.

The requirement to have an open and informative facilitator led discussion was put forth in the IM needs analysis, to ensure an effective intervention was produced. To encourage student behaviour to engage in group discussion, game mechanics were added to help the facilitator control and lead the game play. This approach allowed the facilitator to inspire the students to participate in the games suggested discussions whilst remaining in control of the lesson. The game componants that were chosen to aid the facilitators were as follows;

- Section choices – The facilitator could choose to play through part one which focused on a question and answer style or part two that focussed on role play.
- Scenario choices – This allowed facilitators to choose the appropriate scenario to play out. This was added so that the game had greater scope and control with different year groups with appropriate game material.
- Pause/Skip functions – These functions similar to a dvd menu provided the facilitator with the ability to either pause the whole game to participate in discussions or to skip back to areas of the game that may have been played too fast or further information was needed.
- Timer – A timer was added to section one to help facilitators control the amount of time spent on each question. This mechanic was installed to allow facilitators to lesson plan and to encourage students not to waste time.

These componants act as supporting resources within the game that were inspired from the 4DF approach. Including these methods of support for the facilitator increases end usability and stimulates the aesthetic experiences for the player.

Pedagogic Strategies and Educational Game Content

In order to provide an effective e-learning intervention, considerations for how to embed the learning content into PR:EPARe without deterring student engagement were undertaken, following a set of change objectives outlined from the IM needs analysis. From this, a refferel to strategies set out in the

IM program objectives section for approaching change in the determinant types were observed. The determinants that were addressed included:

- Knowledge
- Attitude
- Optimistic Bias
- Self-efficacy
- Subjective Norm

This strategy was adopted for inserting the change objectives and pedagogic aims set out in the programmes overall goals to fit within the games content and provide an effective intervention.
Methods were adopted that involved the participants to display a higher level of interaction with the game. Participation, discussion, belief selection, guided practice and feedback featured highly in the method selection amongst others, to promote active learning with the students.

Referring to the 4DF model's section on pedagogy, similarities were drawn between the methods found and the suggestions to implement an active learning experience in order to achieve the learning outcomes. The 4DF and LM-GM presents a view that to achieve the learning objectives a serious game should look to apply social/situated, associative and cognitive learning strategies. In essence the game should look to apply cognitive thinking, observation, discussion and role play scenarios to achieve an effective application. The information provided from these models led to chosen design methods such as discussion and participation to provide the base for developing the games mechanical content.

As highlighted in the 4DF, feedback was a vital part to forming an effective learning experience. To address this, 3D NPC (non-playable character) host characters were used to deliver the subject's material source. The NPC's were used to provide information and context before and during a game scenario, and then used to provide formative feedback once an answer was submitted or a scene played through. This created a responsive learning experience that constantly fed back to the learner allowing for self-reflection and conscious response to the subject material.

Evaluation Design.

The evaluation developed and conducted involved a small-scale cluster randomised controlled trial (RCT) of part 1 of the PR:EPARe game delivered in RSE sessions in schools (study 1), and a pre-post evaluation of the whole game (parts 1 and 2). Standard RSE delivery was used as the control for the Cluster RCT. A 2(time: baseline vs. follow-up) x 2(condition: Intervention vs. control) mixed design was used to assess changes in measures recorded over time and between groups for study 1. A pre-post repeated measures design was used for study 2.

For study 1, all schools across Coventry and Warwickshire were invited to participate in the evaluation study. Three schools representing a range of socio-demographic backgrounds and with pupils from non-white as well as white ethnic backgrounds responded positively to invites and provided a total of 17 Year 9 classes to take part in the trial. In total, 505 participants (males = 253; females = 247; no information re: gender = 5) were gathered. All participants were in school year 9 and aged either 13 or 14 years (one participant reported being 15 years) with a mean age of 13.5 years (Standard deviation = 0.5 years). Data re: age was not provided by 9 participants. Of the 17 classes, 8 were randomized to the control group resulting in N = 207. Nine classes were randomized to the intervention group resulting N = 298.

In study 1, initial baseline data had been collected and from this the students of each participating class were randomly allocated to either the control (standard RSE lesson) or intervention condition (Serious Game based lesson) using a computerized dice. In the week following the delivery of the RSE session participants were asked to complete questionnaire measures again.

For study 2, four schools volunteered a total of 9 Year 9 classes to take part in the study. There were a total of 257 participants (males = 113; females = 140; no information re: gender =4). They were aged 12-15 years with a mean age of 13.88 years (standard deviation = 0.56 years).

In study 2, all classes participated in the Serious Game lesson. The cluster RCT procedure applied in study 1 couldn't be undertaken due to the ending of the school year. However, further studies are predicted to address the lack of data gathered from study 2.

Measures

Self-report questionnaire measures based on change objectives found in Table 2 were devised (identified during the IM process). Table 3 lists the measured variables as published by Arnab et al. (2013).

Table 2. Change objectives

Performance objectives	**Attitude**	**Knowledge**	**Self-efficacy / skill**	**Subjective norm**	**Optimistic bias**
1.Respond effectively to coercive sexual behaviour to achieve outcome in line with own preferences	Expect there to be negative consequences of allowing unwanted sexual advances to continue	Identify nature and levels of sexual coercion	Express confidence in ability to recognise all types of sexual coercion	Explain that peers and older others recognise and respond effectively to coercion to avoid it	Understand the risk of sexual coercion and need to respond as personally relevant
1a. Identify discomfort with sexual request or behaviour	Identify low level coercion as negative	Label low levels of coercion as coercion	Express confidence in identifying low level coercion	State that peers and older others feel uncomfortable with coercive sexual requests and behaviour	
1b. Say no or clearly indicate discomfort with request or behaviour	Evaluate saying no to low level coercion as positive	Identify saying no as a possible response	Demonstrate confidence in saying no to low level coercion	Explain that peers and older others say no when they experience discomfort with a request or behaviour	
1c. Identify any further manipulative responses/requests to a clear "no" or indication of discomfort	Identify persistence with coercion as particularly negative	Recognise how coercion levels may increase	Express confidence in ability to identify continued or increased coercion		
1d. State adamance about not wanting to go along with request or behaviour, whatever tactic is used	Evaluate persistence with a negative response as positive	Identifying continuing to say no as possible	Demonstrate confidence in saying no in the face of resistance to earlier negative	State that peers and older others persist with making their negative response clear	

Performance objectives	Attitude	Knowledge	Self-efficacy / skill	Subjective norm	Optimistic bias
			responses.		
2. Deal with temptations to use sexual coercion	Express the belief that coercive sexual behaviour has negative consequences for those that coerce others and those who are coerced	Identify nature and levels of sexual coercion			Recognise that anyone can potentially exert coercion on someone else, and see it as personally relevant
2a. Recognise own desires for sexual activity might be incongruent with others	Assess a partner's desire not to do something as a positive.	State that a simple incongruence in sexual arousal could lead to coercion.	Express confidence to recognise incongruence in desire to progress or engage in certain behaviours between self and partner	Appraise peers and older others as experiencing incongruence in desire during sexual activity	
2b. Stop making a request or performing a behaviour when a negative response is received	Evaluate stopping in response to a no response or aversive action as positive	Identifying stopping as an option	Express confidence in ability to stop		
3. Seek support from an appropriate place when sexual coercion is causing difficulty	Describe seeking support in relation to sexual coercion as positive.	Identify nature and levels of sexual coercion			
3a. Identify an organisation, trusted adult or friend with whom to discuss concerning or repetitive coercive behaviours or requests		List organisations, known and trusted adults and friends who could offer support and advice about experience of coercive behaviour		State that peers and others seek advice about coercion if it becomes a difficulty.	
3b. Discuss and decide on appropriate action	Value the opportunity to get assistance on this issue highly.		Express confidence in ability to discuss experience of coercion with identified appropriate source of support.		

Table 3. Measured variables (Arnab et al. 2013)

Questionnaire measure	Control (no game) condition		Intervention condition	
	Baseline	***Follow-up***	***Baseline***	***Follow-up***
Confidence in knowledge Q1	1.75 (0.71)	1.38 (0.21)	1.93 (0.64)	1.72 (0.55)
Personal relevance (coercee) Q2	2.54 (0.97)	2.90 (0.45)	2.78 (0.76)	2.79 (0.69)
Personal relevance (coercer) Q3	3.36 (1.17)	3.27 (0.44)	3.35 (0.95)	3.22 (0.86)
Negative consequence beliefs (personal) Q4	2.45 (0.96)	2.25 (0.34)	2.50 (0.80)	2.43 (0.69)
Negative consequence beliefs (others) Q5	2.73 (0.80)	2.6 (0.32)	2.83 (0.68)	2.58 (0.67)
Positive attitude to saying 'no' (coercee) Q6	1.59 (0.70)	1.4 (0.28)	1.57 (0.62)	1.64 (0.61)

Positive attitude to saying 'no' (coercer) Q7	1.52 (0.67)	1.58 (0.29)	1.62 (0.56)	1.69 (0.67)
Confidence to say 'no' (coercee) Q8	1.93 (0.91)	1.92 (0.32)	1.99 ((0.73)	1.89 (0.63)
Confidence to recognize self as coercer Q9	2.01 (0.76)	2.03 (0.35)	2.13 (0.67)	2.01 (0.52)
Confidence to recognize coercion against self Q10	1.89 (0.70)	1.77 (0.29)	1.92 (0.65)	1.87 (0.58)
Communication confidence (coercee) Q11	2.12 (0.75)	2.13 (0.34)	2.14 (0.69)	2.14 (0.56)
Communication confidence (coercer) Q12	2.32 (0.86)	2.25 (0.34)	2.24 (0.68)	2.20 (0.66)
Descriptive norm – under pressure Q13	2.51 (0.89)	3.80 (3.84)	2.62 (0.77)	2.48 (0.62)
Descriptive norm – say no Q14	2.42 (0.79)	2.38 (0.29)	2.34 (0.64)	2.23 (0.58)
Subjective norm – under pressure Q15	2.11 (0.88)	2.13 (0.28)	2.10 (0.74)	2.17 (0.65)
Subjective norm – say no Q16	2.02 (0.74)	2.00 (0.28)	1.87 (0.61)	2.04 (0.60)

All questionnaire items were scored from 1 (strongly agree) to 5 (strongly disagree) when the data were input into statistical analysis software. Thus, a lower score on each item represents a lower risk of being coerced or putting pressure on someone else to do something they are unhappy with and greater psychological preparedness for responding appropriately to potentially coercive situations. Qualitative data was gathered from students and teachers who supplied feedback via face to face interviews. Sit-in-sessions of the trial carried out by researchers also took place and from this, observational data was recorded.

To prepare the data for analysis, the questionnaire responses for the 16 change objectives taken at baseline in studies 1 and 2 were combined and subject to exploratory factor analysis, to identify the underlying structures being measured by the questionnaire. The analysis suggested that there were 5 underlying factors represented in the data but questionnaire items only actually loaded onto the first 3 factors. Therefore, the data were re-analysed using principle components analysis with a forced three factor solution and varimax rotation.

Three factors were identified from this which represents the underlying structures measured by the questionnaire. These structures represent:

- Confidence to recognise coercion and act to stop (factor 1)
- Knowledge and positive attitudes towards saying no/others saying no (factor 2)
- Understanding of personal risk and consequences for all (factor 3)

All factors demonstrated reasonable internal reliability with Chronbach's alpha scores of .573 and above. Split half reliability analysis also showed reasonable levels of correlation indicating scale reliability

Inferential Data Analysis

A 2 (condition: control vs. game) x 2 (time: baseline vs. follow-up) mixed multivariate analysis of variance (MANOVA) was applied to the data to assess whether the PR:EPARe game had any impact on the psychological factors identified in the questionnaire data (see Table 4 and Table 5). The MANOVA demonstrated a significant main effect of time ($F [3, 501] = 2.847$, $p = .037$, $\eta \frac{2}{p} = 0.017$), a significant main effect of condition ($F [3, 501] = 7.27$, $p < .001$, $\eta \frac{2}{p} = 0.048$), and a significant time by condition interaction ($F [3, 501] = 15.306$, $p < .001$, $\eta \frac{2}{p} = 0.084$). This finding suggests that the PR:EPARe game does have an impact on the identified change objectives. In particular the time by condition interaction indicates that there may be changes over time in the game condition compared with the controls that are important. Follow-up analysis of variance (ANOVAs) produced in the analysis were consulted to identify which psychological factors were affected.

- For factor 1: confidence to recognise coercion and act to stop, there was a significant main effect of time (F [1, 501] = 4.746, p = .030, $\eta\frac{2}{p}$ = 0.009) but no significant time*condition interaction (F [1, 501] = 0.406, p = .524, $\eta\frac{2}{p}$ = 0.001).
- For factor 2: knowledge and positive attitudes towards saying no/others saying no, there was no significant effect of time (F [1, 501] = 1.902, p = .168, $\eta\frac{2}{p}$ = 0.004) but there was a significant time*condition interaction (F [1, 501] = 7.808, p = .005, $\eta\frac{2}{p}$ = 0.015).
- For factor 3: understanding of personal risk and consequences for all, the main effect of time approached significance (F [1, 501] = 3.35, p = .068, $\eta\frac{2}{p}$ = 0.007) and there was a significant time*condition interaction (F [1, 501] = 27.717, p < .001, $\eta\frac{2}{p}$ = 0.052).

Table 4. Study 1 questionnaire factors by condition and time

Questionnaire factor	**Control (no game) condition**		**Game condition**	
	Baseline	Follow-up	Baseline	Follow-up
Confidence to recognize coercion and act to stop Factor 1	2.12 (0.53)	2.08 (0.23)	2.13 (0.42)	2.06 (0.43)
Knowledge and positive attitudes towards saying no/others saying no Factor 2	1.79 (0.47)	1.70 (0.17)	1.82 (0.39)	1.85 (0.44)
Understanding of personal risk and consequences for all Factor 3	2.72 (0.55)	2.97 (0.82)	2.82 (0.50)	2.70 (0.45)

Table 5. Study 2 for questionnaire factors pre and post gameplay

Questionnaire factor	**Baseline**	**Follow-up**
Confidence to recognize coercion and act to stop Factor 1	2.19 (0.48)	3.10 (1.4)
Knowledge and positive attitudes towards saying no/others saying no Factor 2	1.90 (0.44)	2.33 (1.09)
Understanding of personal risk and consequences for all Factor 3	2.78 (0.47)	2.64 (0.73)

These findings suggest that for confidence to recognise coercion and act to stop (factor 1), an improvement is seen for both conditions overtime. The improvement is better for the game condition but this difference in improvement is not significant. For knowledge and positive attitudes towards saying no/others saying no (factor 2) the control group appear to improve over time compared with the game group. For understanding of personal risk and consequences for all (factor3) the interaction effect demonstrates an improvement for the game condition and not for the control group.
In order to analyse the study 2 data, a repeated measures MANOVA was conducted comparing baseline and follow up psychological factors. There was a significant overall difference in scores at follow-up compared with baseline (F [3, 254] = 39.812, $p < .001$,,$\eta_p^2 = .320$).

ANOVAs demonstrated that there was no significant change for *confidence to recognise coercion and act to stop* (factor1) (F [1, 256] = 1.967, $p < .162$, ,$\eta_p^2 = .008$), there was a significant decrease in

knowledge and positive attitudes towards saying no/others saying no (factor2) (F [1, 256] = 39.625, p < .001, ,η_p^2= .134), but a significant improvement in *understanding of personal risk and consequences for all* (factor3) (F [1, 256] = 9.042, p = .003, ,η_p^2= .034). These findings mirror to some extent the outcomes from the study 1 findings. Although we now have a null finding in relation to *confidence to recognise coercion and act to stop* (factor1), the impact of the game is again shown to be unfavourable in relation to *knowledge and positive attitudes towards saying no/others saying no* (factor2) but to have a positive impact on *understanding of personal risk and consequences for all* (factor3).

Overall the analysis of observation data presented suggests that blending the interactive game-based approach with traditional classroom delivery encouraged teachers and students to engage in communal discussions and debriefing during and after game play. Together, the results demonstrated real benefits for pedagogy-driven game-based intervention for supporting the delivery of RSE within a classroom setting, which provides a validated test case for the trans-disciplinary development model in the next section.

Discussions: Towards a trans-disciplinary development methodology

Games by their very nature require the development skills of multiple specialists such as artists, designers, animators and programmers, in order to create one game. Whilst this in itself is often a challenging task, to converge various expertise and abilities within a similar discipline to produce a game, SG present an even greater challenge due to their multi-disciplined nature. SG are platforms in which two or more disciplines are combined to create engaging learning experiences and linking these with the original complexities of developing digital games highlights that the creation of a multi-disciplined digital learning tool is not a straightforward task.

As reflected in previous sections, the general development process was iterative and participatory, reflecting a game development life cycle (GDLC, Ramadan & Widyani, 2013). Ramadan & Widyani (2013) emphasised that simply adopting the software development life cycle (SDLC) for game development is inadequate, as the developers face several challenges during its life cycle, which will require an iterative pre-production, production and testing cycle, producing alpha, beta and the actual release version (figure 6). For the GDLC, the final release stage will roll out the product into market.

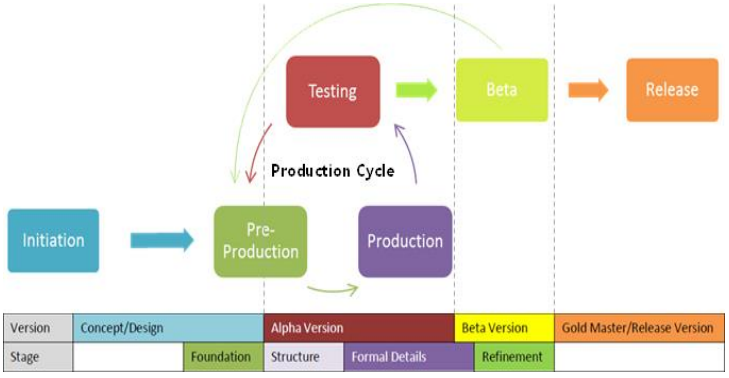

Figure 6. Digital Game development life cycle (Ramadan and Widyani, 2013)

SGs development project however adds another layer of complexities as SGs aim to facilitate both outcomes in terms of entertainment (engagement) and the serious outcomes (impact). Therefore, for SG development, the release phase of GDLC will go through post-production evaluation, key to ensuring that the SG is evaluated in operational environment, key to assessing the success of the

intended intervention. The general development lifecycle serves as a guideline, which will require specific considerations that will determine the desired outcomes (knowledge, attitudinal, behavioural) from the game-based intervention and the pedagogical implication of the approach.

The overarching trans-disciplinary development process

SG development thus has three iterative phases of production, implemented before the product is rolled out in a larger scale: the pre-production phase, the production phase and the post-production phase (release phase). Assigning separate stages to the production schedule allows the research and development (R&D) team to designate functional strategies into each specialised area of development. The 4DF dimensions provide an overarching perspective of considerations important to a user-centred SG design that put emphasis on the need to balance entertainment with pedagogically sound content and context for deployment. The IM approach provides a robust process for designing, deploying and evaluating intervention programmes. The entertainment gaming considerations are based on MDA and the ludo-pedagogical constructs of LM-GM bridges these gaming considerations with the desired outcomes of the intervention.

Building on these perspectives, 4DF and IM act as the overarching models (see figure 7) that inform the development cycle of PR:EPARe, from the pre-production through to the post-production stage. The procedural approach of IM when infused with the dimensions of 4DF provides a structured and informed perspectives of game-based intervention development, collectively reflecting a participatory development approach. This subsequently provides the basis upon which other theoretical and methodological frameworks can be embedded, such as the MDA and the LM-GM models in order to marry the pedagogical (serious) aspects with the entertainment attributes of gameplay.

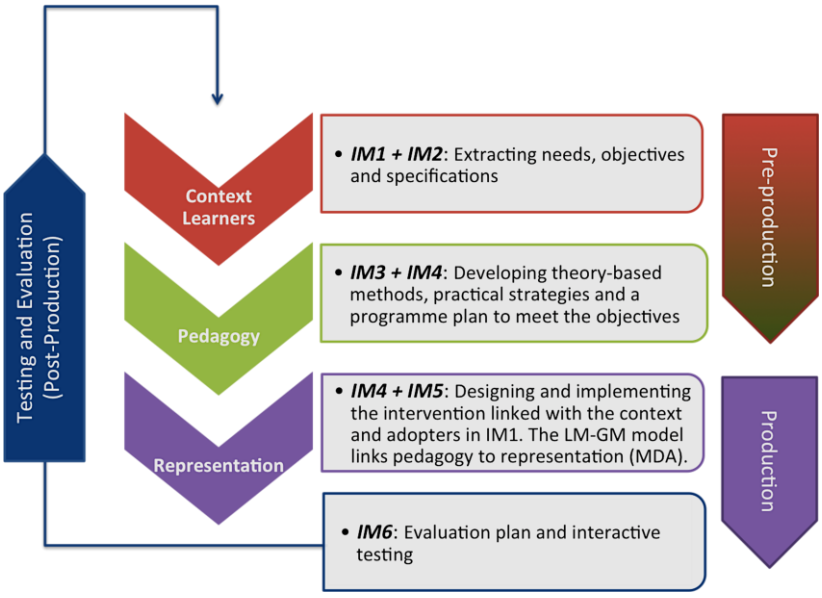

Figure 7. The overarching trans-disciplinary model infusing 4DF and IM within the production chain

The general design of PR:EPARe was driven by the 4DF emphasising the *context* of deployment, *learner* profiling and *pedagogical* perspective that influence the mode of *representation* of the learning content. To support the 4DF's dimensions, the IM approach was implemented to ensure that the factors associated with what puts young people at risk of sexual coercion (the topic for the game) were addressed. The IM approach is commonly used to guide the development of health promotion interventions/programmes and involves six activities/steps (see Brown et al., 2012). While the 4DF model provided the overall considerations for the development of the game, the IM approach provided identification and analysis of the needs of the end-users relevant to experience of sexual coercion

(IM1), objectives or targets for change (IM2), and strategies and plan (IM3, IM4) for the game-based solution. The game was implemented as part of IM5 and IM6 involves the pilot and trials of the game.

Phase 1: Pre-production

The Pre-Production phase (figure 8) is the planning and concept development stage of the project cycle. This phase can be further broken down into five stages that map against the 4DF, IM, MDA and LM-GM processes.

Figure 8. Pre-production stage

Needs Analysis

The needs analysis is an approach taken from Bartholomew's IM model that was used in the pre-production phase of the PR:EPARe project. A needs analysis is a method to assess the intended health related problem and its conditional determinants in order to highlight the overall programmes goals of the intervention. A planning group is used to assess behavioural and environmental factors of the health problem with the help of a logic model, in the case of PR:EPARe the model was based off Green and Kreuter's PRECEDE model (Green and Kreuter 2005).

In the needs analysis adopted for the development of PR:EPARe, the evidence that was to be reviewed in this stage was gathered from initial professional and young person's (12-16 year olds) stakeholder meetings that developed ideas on the needs and wants of a game based intervention. In this stage SASH identified issues and content from the initial stakeholder feedback and a secondary selection of stakeholder meetings and found similarities between certain issues and concerns raised. These issues were taken forward to form recommendations for the games topic, content and goals. The evidence gathered from the needs analysis allowed the project team to draft overall programme goals in an effort to focus the production of the intervention. This was then validated by steering group's members who agreed that the intended projects topic and goals would provide a relevant and useful addition to the present RSE curriculum.

The evidence presented from PR:EPARe's evaluation and the analysis provided from the data indicates that the needs assessment provided a vital insight into the needs, concerns and wants of the intended clients, practitioners and users. By gathering information from staggered stakeholder group meetings and analysing the feedback, arising similarities in the data could be used to form a clearer reflection of what the intervention should encompass. This process forms a fundamental point to the development of a game-based intervention and incorporates the use of participatory design into the development methods. The needs assessment strategy utilises evidence gained from involved sources which should have an invested interest in the intervention approach. As such, evidence gained from

these sources should contain insightful factors to be considered as to the format and development of the intervention.

Through the adoption of the Needs Analysis techniques, such as creating a comprehensive review; understanding current research and gaps surrounding the problem, planning groups; to assess any behavioural and environmental factors and stakeholder meetings; to ascertain ideas and feedback for user content, accurate information can be ascertained and implemented at the concept development stage.

To conclude, the use of the needs assessment carried out in the pre-production phase is indispensable in the development process in order to determine client and user based recommendations to support the intervention. Without the support from the stakeholder feedback gathered in the needs analysis approach, the overall research to the project would become less accurate concerning the essential requirements of the intended client and user groups. This in turn could affect the overall acceptability, engagement and efficiency of the intervention.

Pedagogic and Methods Strategy

Following the Needs Analysis feedback, focus is drawn on developing the learning methods and outcomes that are to be imbedded into the SG. Whereas the Needs Analysis provides the context needed to develop the research objectives, the Pedagogic and Methods Strategy is used to establish the projects learning outcomes and the subsequent methods of delivery and assessment that are required to achieve the projects objectives.

The 4DF (Pedagogy) and the IM (step 3) models both propose determining at an early stage the learning/behavioural outcomes and the development of practical strategies in which methods that are grounded in learning theory are used to address the project objectives. Outlining clear learning objectives early provides the development team defined goals to achieve in the production stage.

Theory based methods adopted from the IM model are used to help identify the methods and practical strategies needed to deliver the objectives of the programme goals. This approach developed alongside pedagogic considerations is used to set educational goals and map appropriate methods of delivering the training content to end users. This technique of theory-based method selection was adopted in the pre-production phase of PR:EPARe to identify methods and practical strategies used to deliver the change objectives set out in the IM step; programme objectives. This was done to ensure that t objectives set out would have the best chance of users identifying with them and as a result the overall programme goals would be met.

As an example from the PR:EPARe method selection table, one change objective outlined from the programme objectives state that users need to *identify continuing to say no to coercion*. The methods that were adopted to help deliver this objective were identified as participation, discussion and feedback. Using these identified methods, the application of these were then developed into the game content to allow players to identify saying no as a possibility and were then reinforced through feedback. As a result to this approach, the development team were provided with useful instructions as to how objectives were to be met and how information was to be delivered through the games content.

In the overall process of theory-based method selection provided informed choices that were to be set out in the concept document. This process provided the much needed data to support the process of developing the games theme and base mechanics. In essence this approach saved the development

team time and resources as the methods had already been mapped out ready for the concept document and development meetings. With the development and design team knowing that certain methods had to be used in order to obtain the programme objectives, a focus was drawn in pre-development meetings to relevant material and thus this ensured that the concept and design of the game followed specific set instructions to its development.

The evidence to support this approach for future game and intervention approaches show that one of the methods chosen, discussion, was linked to positive qualitative feedback expressed by both students and practitioners whilst using PR:EPARe. The method of discussion and its related means such as participation and feedback were chosen to deliver specific programme objectives. The reflective analysis of this data proved to show positive results with comments being made as to the useful application of this chosen method. Students were reported to have enjoyed contributing their opinions and hearing their peer's views. Equally, practitioners were keen to express that students seemed to be involved with discussions and were engaged throughout the play-through of the game.

Pedagogic design is intended to be developed alongside the theory-based methods selection, providing pedagogic theory and objectives for the methods to be mapped against. Adopted within the development of PR:EPARe was the need to outline programme objectives in order to achieve method selections, the process incorporated into this design model outlines pedagogic considerations and theory before method selection can take place. This approach is developed from both the IM, LM-GM and 4DF models with an emphasis on the pedagogic theory and content that the game needs to consider to provide an efficient approach to serious games development. These models are also combined to provide a wider scope for serious game development, drawing focus to pedagogic objectives and mechanics alongside intervention objectives for assistance in all serious game development. Based from the IM's programme objectives step, the pedagogic design section methodology incorporates the task of underpinning the learning objectives to be integrated into the game. Outlining clear learning objectives early provides the development team defined goals to achieve in the production stage. Furthermore, methods can then be selected from this process, ensuring that the right learning objectives are matched with the right methods and application.

The Pedagogic design section highlights the formal and informal learning processes that are to be implemented into the project in order to achieve the programme's overall goals. This section makes use of the information gathered in the needs analysis and instructs the development team to formalise the feedback gathered from this process into learning objectives to be set out in the game. Pedagogic theories are reviewed at this point to ensure that the intended learning content is compatible with a technological delivery. Such theories to support these claims include the constructivist theories (Dewey 2013; Piaget 1970; Vygotsky 1980) which encourage experimental learning.

Of course, other pedagogic or learning theories can be considered in place of the constructivist theory and are often found in serious games. Other theories such as collaborative learning are often used in group based serious games for triggering learning mechanics that apply to social situated conditions. Other serious games target the use of the behaviourist approach to pedagogic design that use mastery learning to modify behaviour. Whilst the IM, LM-GM and the 4DF favour cognitive and constructivist methods, various pedagogic theories can be used and blended to create the desired end effect.

The evidence to support this sections inclusion into the trans-disipinary model stems from the similar approach of the IM step; programme objectives, used in PR:EPARe's development. By outlining the

projects goals and the change objectives that were to be achieved in the project early, a focus was drawn to how development should take place. This informed the development team of how certain aspects of the game should be designed to incorporate change objectives and learning instructions.

To conclude, a method selection and pedagogic strategy provides a base for the games objectives and application techniques that the development team can work from without having to waste valuable time and resources beforehand. Knowing goals and learning objectives from an early start allows for additional time developing evaluation strategies and ensuring accurate methods are being adopted for the games evaluation phase. This approach can provide assistance to the development team early in order to underline the material that is needed to ensure efficient game-based interventions are developed.

Aesthetics & Learning Objectives Mapping

In this section attributes from the MDA and LM-GM models are considered to aid in the development of serious games. The MDA encourages the use of selecting user experiences to aid development of an engaging game. These user experiences suggested by the MDA which are outlined to include aspects such as fantasy and competition can be connected to chosen methods and applications that have been previously laid out in the needs assessment and pedagogic and methods strategy sections to attach a suitable game and user experience in order to maintain a coherent game. To shape the experience of the game and encourage user engagement, once delivery methods are outlined by matching pedagogic objectives to theory-based solutions, game experiences based from the MDA approach should be chosen to compliment the chosen delivery methods. For example, if the pedagogic objectives outline delivery methods that consist largely of end users experiencing role-play to achieve results, then a user experience such as fantasy should be chosen to achieve a style suitable for the games material. Consultion of the MDA, provided user experiences that matched to the intended delivery methods, allowing for a game to be compatibly designed alongside the pedagogic objectives set out. This approach was adopted in the development of PR:EPARe, using game experiences from the MDA to link with the methods set out for delivering objectives. By combining the IM and MDA approaches to delivering objectives and content experiences, a representational frame quickly emerged concerning the base functions and game content. Finally, the LM-GM model is used to identify different aspects, abstract and concrete, of learning mechanics and game mechanics that are used to inform the pedagogic delivery style that the game should take within the game mechanics.. The complete mapping is discussed in Arnab et al. (2013) elaborating on the selected mechanics relevant to the learning and game interactions designed for the game play. An example of the pedagogic-game mechanic map based on part 1 of the game is illustrated in figure 9, which mirrors a state diagram (inspired by the Unified Modelling Language (UML)).

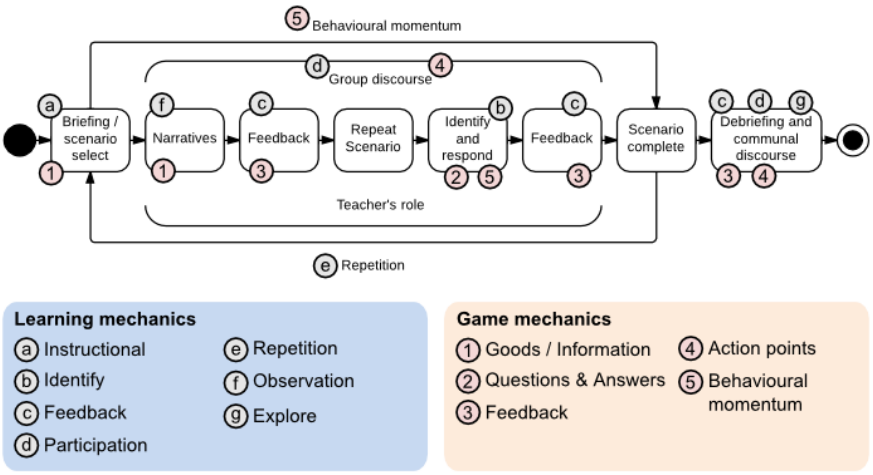

Figure 9. Example of the LM-GM mapping of PR:EPARe game play flow for Part 1 (refer to complete mapping in Arnab et al. 2013)

The evidence to support the use of this method is drawn from the feedback in PR:EPARe's evaluation, which highlighted the users engagement with the competitive nature of PR:EPARe. The use of competition instilled into the game was taken from the aesthetics table to complement the methods and applications set out.. The evaluation feedback commented that the students accepted the competition within the game and as a result appeared to think about and respond carefully to the questions presented. The students seemed to care about their answers and as a result a greater level of attention to the concepts and material presented was displayed.

Technology and End User Requirements Planning

In the Technology & End User Requirements Planning stage, considerations should be drawn to address the technological, environmental and user-based constraints of delivering a serious game. One of the fundamental questions at this stage is the context of the programmes delivery and its intended environment: classroom, workshop, home, practitioner-led, stand-alone or group.

As the PR:EPARe project required a facilitator to deliver the game in a classroom environment with differing class sizes, it was important to address that the end users in this project were to be the facilitator and the student. This led to an in-depth analysis of practitioner centric design as well as the learner centric design to ensure acceptability and engagement was achieved on every level of the game.

Traditionally serious games tend to focus solely on the learner and forget to develop the practitioner needs. An effort made in this area will allow practitioners to feel that the game based product they are delivering is an efficient and simple to use, educational tool.To address practitioner design in the project PR:EPARe, the development team applied several functions that would aid the delivery of the game. These functions included;

- Pause and Skip function – These functions allowed the facilitators to control the speed of the game. If further discussion was needed on a particular area of the games content then the facilitator could pause to allow discussion to take place without missing other content. If the facilitator needed to show game content again to ensure that the class have covered the material in full then they could use the skip function to skip back to previous material.
- Timer – The timer function was installed in part one of the game to help control the pace of the game, and to help combat students dithering too much over one question. This function

was installed to help teachers manage their lesson planning and provide help towards time management.

- Feedback Screen – This function listed all of the main points of consideration for the topic of coercion for each area of the game. This provided a summary of the key points for class discussions.

By adopting these kinds of functions in to the project's design that are primarily useful to the practitioner, the aim is to achieve a level of acceptability and engagement as specific design choices have been made to acknowledge the practitioner as an end user. In turn the choices made from a practitioner centric design point, are made to encourage ease of use and delivery of the final product.

Addressing the needs of the learner as the end user, the game has to be both an engaging game experience alongside a higher level learning experience in order to fulfil the goals of a serious game. In order to tackle this in PR:EPARe, aesthetic choices were made to compliment the methods and applications set out in order to achieve programme and change objectives. The theme and content that were chosen to compliment the aesthetic choices were based off research into popular media and culture such as family games like *Buzz* on the PS3 and the *X Factor Show* in an effort to identify with a younger audience as the end user. Using this research in the overall concept, the theme and content of PR:EPARe was to centre around a game show. By using these concepts the developers wanted the student users to feel comfortable using PR:EPARe by adopting a theme that they could identify comfortably. The theme chosen also led to providing a stable environment to introducing the learning content, as a game show is likely to ask questions, receive answers and be a learning experience in itself. By using a combination of a thematically based environment, visual styles, scripts and aesthetic experiences, PR:EPARe was developed to be fun to play for the student user. The development team wanted to encourage a fun and playful experience for the student user in order to lead to a vested interest in the content and thus aiding engagement of learning content.

The delivery environment plays a role in determining what platform would be a practical host for a SG. It is therefore essential that the development team ensure that the hardware chosen to develop the programme is readily available and that it is compatible for its intended setting.. The IM and the 4DF both consider the use of technology and the effect that it may play on the final product and the user group.

- The IM considers a programme plan which develops the project and its process materials and reviews the effect of these methods on the user group.
- The 4DF has a dedicated section that targets the representation of technology when designing a game. Areas such as fidelity, method, use of hardware and software are considered for their effect on the user groups.

In an effort to support the target user groups, technology and its effects were considered when choosing how to develop the game effectively. Areas such as delivery, context and equipment limitations were measured to ensure the developers took accurate measures to improve user engagement and facilitate product delivery. Planning technology considerations and end-user requirements inform the development process in which the developers can assume that the programme will be functional and user friendly.

Evidence to support the use of end user requirements and technology planning, is gathered from the analysis of the evaluation data of the pr:epare game. In response to the practitioner centred design that was adopted, the feedback shows that comments made from the practitioners stated the practicality of the functions such as pause and skip and the technology used. These were listed as being valuable

functions in helping control the delivery and flow of the lesson. In evidence to support the leaner centric design employed, comments were raised that the students were engaged with the competitive element and theme of the game and as a result the students were found to be active in the discussion based activities.

Concept Development

The Concept Development stage is used to bring together all of the previous elements gathered from the pre-production phase which are then fleshed out and fitted together to form the game's overall concept. This method refers to Step 3 of the IM model in which program materials are considered and designed to reflect the projects overall goals. A concept document is put together to show the flow of the games theme, content, the learning objectives, visual style, script and all other aspects that need to be considered in order to develop the game. The concept document provides a good reference point for all involved in the project's development which is especially useful when different teams are working on different sections of the game. Using a document ensures that each team is kept up to date with the relevant project and games development information.

In the development of PR:EPARe, an initial concept document was put together and was systematically updated throughout the project lifecycle. This document provided easy access to relevant information to all members of the team. The document contained amongst other important data, the learning objectives and materials developed from the needs analysis and the theory based methods selection. Developing a concept document in the early stage pre-production meetings, every member of the team, regardless of their disciplinary background, could follow the intended course of the games development. In short, this document allowed the development team to quickly come up with themes and suitable suggestions to fit the needs that had been previously outlined, saving time that would usually be wasted on suggesting detrimental proposals.

In this phase, all elements of the game should be brought together to create a framework of a working serious game. This is the final step before production starts, so it is important to flesh out ideas and incorporate adequate research into the games concept before development starts. This approach ensures that the development team are using their time wisely and following precise instructions set out in the document. This is an iterative process so reviews should be conducted when development starts, however it is advantageous to provide a solid concept before development begins.

The concept stage requires that the flow of the game is laid out and fits all of the intended learning and programme goals. Technical specifications are highlighted to ensure that the end product meets the end environment with no difficulties, with specialist hardware considered. Programmers are consulted on the coding, software or hardware requirements of the games development and are instructed to flag any difficulties for seen with the intended concept laid out. Designers are consulted on the game design, user design, mechanics, visual aspects and overall style of the game to help provide an engaging experience for the users and deliver an entertaining game. Researchers and subject experts are also consulted to oversee the production, help maintain the learning content of the game and ensure that research objectives are being met and the interventions information is being delivered correctly.

Using a concept document to control all of the games vital information provided an easy way to share this information across different teams working on the game. Having developed PR:EPARe's conceptual work from the initial concept document provided before production began, the development team could focus on factors and time scales involved for each section. Without the

concept development from an early point, time would have been wasted on developing unnecessary assets and explanations.

As an example to support this theory, the concept document was used to help explain the technical requirements of the game to our technical development team based in Singapore. Language barriers and time issues provided problematic experiences in this area; however by using the concept document, the Singapore team could read a detailed explanation with the relevant images to gain a greater insight into the goals that the team was looking to achieve.

To conclude, personal experience from the PR:EPARe project indicates a strong emphasis of concept development at an early stage in a production cycle. Experience suggests this is a necessary step to ensure that the project meets goals and is developed according to the needs and requirements of the clients and users. Once concepts are developed they should be documented with a concept document to outline the games elements and concepts. The process of concept documentation is invaluable, especially when working as part of a participatory project with multiple teams with multi-disciplinary backgrounds.

Phase 2: Production

In the Production phase (figure 10), information and feedback that is gathered from the Pre-Production phase is actioned and physical development of the programme commences.

Figure 10. Production stage

Game Development

In the Game Development phase, practical expansion of the programme is initiated and development is guided by the previously determined objectives and feedback gathered from the Pre-Production stage. Development is informed by Step 4 of the IM model in which program materials are developed. Within this stage the development team pulls together all of the essential research and designs conducted so far throughout the project in order to begin the material development of the platform.First-run iterative aspects of the game are conceptually established by the Game Development phase with clear game development goals laid out. Programmers, designers, researchers,end users and all other members of the project are involved with the Game Development process, ensuring that user feedback is implemented. Iteration and participatory development is used to ensure that the games content meets overall targets such as developing clear learning objectives or developing user motivation and acceptability.As an iterative process, development conducted at this stage should be open to user feedback and iteration to ensure that the games development fulfils targets such as learning objectives and shows acceptability within the user feedback. This stage encompasses all of the physical and technical aspects of the games development.

Resource Development
Resource Development is a phase outlined by both the IM and the 4DF considerations, as a method of incorporating additional information or guidance beneficial for the end-user that remains outside that of the virtual environment.

To aid the delivery of PR:EPARe, a facilitators manual was developed that held advice on how to navigate the game, suggested activities, discussion topics and material and held information of contacts for additional support. The manual was designed to act as reference point for the facilitators, support and outline the learning outcomes and aid ease of use. Furthermore, the manual provided the facilitator with an instruction on how to guide the lesson; this allowed a level of consistency in the delivery even considering teachers various delivery approaches.

A Facilitator Manual is one example of an external resource that could be developed to support the delivery of a virtual platform. Additionally, other resources could include information on the project's educational focus that can be accessed outside of the virtual world including; seminars, help groups, local information and anything else that could aid knowledge transfer of the subject matter.
The evidence provided in PR:EPARe's analysis indicate that there are benefits to providing additional resources alongside the game to support guidance and consistency elements that arise with their use. In an effort to ensure that the game is delivered and understood in the correct manner, it is important to provide additional guidance which can be accessed outside of the game. It also provides a method for facilitators to understand the game and its concepts before applying it in the classroom setting. In doing this the facilitator should feel comfortable applying the game which in turn should promote acceptability and engagement in the facilitators, one of the end users.

Alpha/Beta Testing
The Alpha/Beta Testing phase is highlighted in both the GDLC and the UCD processesas a necessary stage in the production cycle for games and technology. As shown, early versions or prototypes (Alpha/Beta) of a game are iteratively tested by in-house personnel and select end-users before a final version of the game is released to the wider public.

The Alpha prototype is tested in-house with members of the development team. Adjustments to high-end game content such as but not limited to; learning mechanics/game mechanics, subject information and usability considerations are tested at this point and further refined before being taken to the Beta phase.

The Beta prototype is tested by a limited number of external end-users. In the Beta phase, end-user feedback is gathered and used to make informed decisions about any additional changes needed to the product. End-user testing provides a good insight into the acceptance, usability and perceived usefulness of the game amongst its intended audience.

Phase 3: Post-production
The post-production stage can be broken down into three stages (figure 11).

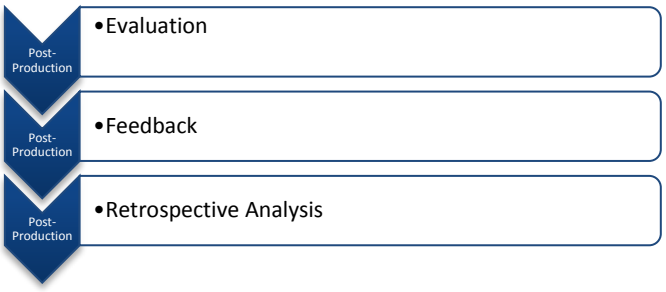

Figure 11. Post-production stage

Evaluation

An evaluation strategy (previously created in the Needs Analysis section of the trans-disciplinary model) informed by the IM model, is implemented at this stage and is used to gather data and to assess the overall efficiency and impact of the projects transfer of knowledge to the end-users groups. Quantitative and/or qualitative data is gathered and used to assess any changes in user knowledge against the metrics and learning outcomes laid out in the evaluation criteria. Evaluation, as laid out by the IM processes and 4DF dimensions, of the final product is essential to understand the influence that the programme has had on its target users. The data and information gathered from this stage informs future development of e-learning content and serious games development.

In the PR:EPARe project the evaluation strategy to access the game's efficiency relied on gathering both quantitative and qualitative feedback from the participating schools trials. The qualitative data was gathered by members of the research team that observed the delivery of the game in the schools. By gathering both sets of data in the evaluation phase, a clearer indication on the efficiency of the game and its user impact can be gathered in order to provide data for future works and development.
This section of the methodology is essential in the process of developing a serious game. Without the evaluation and feedback phase, the game cannot be tested on the intended target user groups and data cannot be gathered to see if objectives of the programme were met.

Feedback

The Feedback phase is used to gather and assess any end-user and stakeholder feedback that is taken from the final evaluation phase and is carried out as part of the evaluation strategy which is informed by the IM model. During Evaluation, feedback can be gathered via video, audio or qualitative means in order to measure final considerations of the game from users/stakeholders perspectives. Feedback is used to determine opinions on a range of areas concerning the games content and delivery such as but not limited to; Aesthetics, Usability, Game play, Engagement, Learning Value and Perceived Use. Feedback informs the Retrospective Analysis phase.

As part of PR:EPARe's evaluation strategy verbal feedback was gathered from both students and practitioners and recordings were taken of the class play through of the game. Researchers also asked students and teachers for feedback and suggestions at this stage on how they perceived the game and what could be improved.

Retrospective Analysis

The closing phase of the Trans-Disciplinary model is the Retrospective Analysis that is used to assess the project as a whole and forms a part in the evaluation strategy informed by the IM model. The Retrospective Analysis phase is a reflection period, that brings a focus on determining efficiency of objectives and development methods that have influenced data findings in the project. Reflecting on

the methods adopted in the R&D process, and using the evaluation data as evidence to support or criticise decisions made, provides the development team with a deeper understanding of what works when creating a serious game. It further allows the development team to build upon the game created so far using the iterative development process and creating variations of the game to coincide with suggestive feedback and data.

Reflecting on the methods adopted in the R&D process, and using the evaluation data and feedback as evidence to support or criticise the choices made, provides a deeper understanding of what works or is less effective when creating a serious game. Using this evidence, the areas that worked in the process can be documented and stored to provide future guidance. It also allows for the team to build upon the game they have created so far using the iterative development process. Further versions of the game can be created by modifying the needed areas that have arisen from the data analysis.

To support the use of this methodology, the application of a retrospective analysis has inspired the development of the trans-disciplinary model by providing data and evidence to support the developments methods that yielded positive results. The trans-disciplinary methodology will as a result be used to assist and guide future works and projects in the area of serious games and game based intervention approaches.

Limitations and further work

In this paper, the main objective and contribution was to infuse and correlate the considerations and methods used in the development of PR:EPARe as an instance of developing a holistic methodology that focuses on combining multi-disiplinary methods from serious games theories, entertainment game techniques, software development, pedagogic theories and health intervention.

The final outcome of this work attempts to addresse the gap in SG research for the need of a procedure that brings focus to a trans-disciplinary development approach to SGs. The concluded framework or methodology as an outcome of the discussion in this paper is a reflection of the process that we went through. Whilst this paper presents a case for a preliminary trans-disciplinary model, we recognise that the model proposed so far has limitations.

The model proposed in this paper is in the early stages of development formed from the evaluation data of the PR:EPARe project. Since the method was developed from the needs and evaluation results of the PR:EPARe game, further use of the development method in SGs outside of the PR:EPARe project would be required to come to an accurate evaluation of the models process efficacy for other serious games design and development. The paper is inspired by the need for design cases that discusses the approaches and considerations taken during the development process. Further work could include applying the trans-dicsiplinary approach in other design and development projects, which could include some form of validation of the benefits and impact.

Future work will thus see the application of the trans-disciplinary methodology in development processes of other SGs or game-based interventions. An evaluation strategy that is designed and carried out on the model itself and examined against various users' feedback, including the development teams, stakeholders, practitioners and end users to assess efficacy of the considerations of the methodology is further proposed, with plans to incorporate evaluation measures such as design and development experience, ease of use, acceptance and engagement with final product.

Conclusions

This paper illustrates how existing design and development processes can be analysed and reflected upon towards documenting considerations, perspectives and methods that can be correlated and infused into a holistic methodology. This paper highlights the feasibility of infusing approaches relevant in different disciplines in order to inform the design and development of game-based intervention. Game development considerations can be deconstructed into four key dimensions using the 4DF model exploiting a participatory-driven context and learner's profiling using the IM approach. The MDA and the LM-GM models allow the pedagogical aspects to be mapped against the entertainment attributes of gameplay.

Reflecting on the development process of the PR:EPARe game, the trans-disciplinary methodology demonstrates a SG development cycle broken into essential stages for consideration, namely Pre-Production, Production and Post-Production. Within these three stages, development phases are used to guide developers to reflect on individual aspects that go towards the creation of a SG. This approach is used to develop essential objectives and game components through-out each stage of the programmes process. This ensures that each phase is thought through purposely for effective outcomes. Adopting a user-centred development method with the inclusion of participatory design facilitates the use of relevant idea generation and feedback to engage the target demographic. This process provides the developers with relevant knowledge to make informed decisions on aspects such as content, learning objectives, aesthetics, mechanics, technologic and usability considerations at the appropriate time during the development cycle.

The components from the different approaches when integrated formulate a trans-disciplinary model that can be adopted by other researchers, designers and developers. This paper discusses the possibility of looking at an existing design and development project and reflect on the process, cosiderations and decisions made, which could be used as guidelines for future development. Further work will include adoptions in other game-based learning interventions that will lead to validations of the process and adopting the same approach in analysing and reflecting on other SG design and development projects.

Acknowledgement

This work has been co-funded by the Health Innovation and Education Cluster (HIEC) for West Midlands (South) and the EU under the FP7 Games and Learning Alliance (GALA) Network of Excellence, Grant Agreement nr. 258169. Complete report of the data in publicly and openly available at the funder's website[1] and there is no conflict of interest. The work underwent strict Coventry University's Ethics approval process under the Medium to High Risk assessment[2]. The author would also like to acknowledge Maira Calvaho of University of Genoa, Italy for the re-illustration of the PR:EPARe LM-GM mapping in figure 10, and the SASH group of ARC-HLI for being part of the development team and the evaluation of PR:EPARe.

References

[1] http://www.wmshiec.org/Our-Projects/Sex-and-Relationship-Games-Part-2

[2] https://ethics.coventry.ac.uk/about/ethics-at-cu.aspx

Arnab S., Lim T., Carvalho M. B., Bellotti F., de Freitas S., Louchart S., Suttie N., Berta R., De Gloria A. (2015). Mapping Learning and Game Mechanics for Serious Games Analysis, British Journal of Educational Technology, 46: 391-411 doi: 10.1111/bjet.12113

Arnab, S., Brown, K., Clarke, S., Dunwell, I., Lim, T., Suttie, N., Louchart, S., Hendrix, M. & de Freitas, S. (2013). The Development Approach of a Pedagogically-Driven Serious Game to support Relationship and Sex Education (RSE) within a classroom setting. Computers & Education 69, 15-30.

Baalsrud Hauge, J, Stanescu , I.A, Moreno-Ger, P, Arnab, S, Lim, T, Serrano-Laguna, A, Lameras, P, Hendrix, M, Kiili, K, Ninaus, M, De Freitas, S, Mazzetti, A, Dahlbom, A & Degano, C (2015), Learning analytics architecture to scaffold learning experience through technology-based methods. *International Journal of Serious Games, 2*(1), 29-44. 10.17083/ijsg.v2i1.38

Arnab,S., Berta,R., de Freitas,S., Earp,J., Popescu M., Romero,M., Stanescu,I., Usart M. (2012). Framing the Adoption of Serious Games in Formal Education. Electronic Journal of e-Learning . ISSN: 1479-4403

Bartholomew, L. K., Parcel, G. S., Kok, G., Gottlieb, N. H, & Fernandez, M. E. (2011). *Planning health promotion programs: An intervention mapping approach* (3 Ed). San Francisco: Jossey-Bass.

Becker, K. (2011). The Magic Bullet: A Tool For Assessing The Evaluating Learning Potential In Games. International Journal of Game-Based Learning, 1(1):19-31

Billings, J. R., Hastie, C. L., Jenkins, L. M., & Macvarish, J. (2007). A Survey of Teenagers' Views of Sex and Relationships Education and Sexual Health Services in Kent. Executive Summary.

Brown, K.E., Bayley, J., & Newby, K. (2012). Serious Game for Relationships and Sex Education: Application of an Intervention Mapping approach to development. In S. Arnab, I Dunwell & K. Debattista (eds.) *Serious Games for Healthcare: Applications and Implications*. IGI Global; Hershey, PA.

Clarke, S. Arnab, S. Dunwell, I. Brown, K. (2012). PRE:PARe – A Game Based Approach to Relationship Guidance for Adolescents. VS Games Conference

Department for Education and Skills. (1999). "National Healthy School Standard Guidance." *DfES Publications*.

Department of Education and Employment (DfEE). (2000). "Sex and Relationship Education Guidance." *London: HMSO* (1006/2000).

Dewey, J. (2013). The school and society and the child and the curriculum. University of Chicago Press.

de Freitas, S. & Oliver, M. (2006). How can exploratory learning with games and simulations within the curriculum be most effectively evaluated? *Computers and Education*. 46 (3), 249-264.

de Freitas,S. & Jarvis, S. (2008). Towards a development approach for serious games in Connolly,T.M., Stansfield,M., Boyle,E. (ed.) Games-based learning advancements for multi-sensory human-computer interfaces: Techniques and effective practices. Hershey: IGI Global

Education Act (1996). Text. Accessed May 12. http://www.legislation.gov.uk/ukpga/1996/56/contents.

Green, L. W., & Kreuter, M. W. (2005). Health program planning: An educational and ecological approach (pp. 227-253). New York: McGraw-Hill.

Gunter, G. A., Kenny, R. F., & Vick, E. H. (2007). Taking educational games seriously: Using the RETAIN model to design endogenous fantasy into standalone educational games. OEducational Technology, Research and Development. 56 (5-6), 511-537.

Hunicke, R., LeBlanc, M., Zubek, R. 2004. MDA: A Formal Approach to Game Design and Game Research. Proceedings of the Challenges in Game AI Workshop, Nineteenth National Conference on Artificial Intelligence.

Kenny, R. F. & Gunter, G.A. (2007). Endogenous fantasy-based serious games: Intrinsic motivation and learning. International Journal of Social Sciences, 2(1), 8-13.

Kiili, K., Lainema, T., de Freitas, S., & Arnab, S. (2014). Flow framework for analyzing the quality of educational games, Entertainment Computing, Elsevier DOI: 10.1016/j.entcom.2014.08.002

Lim, T., Louchart, S., Suttie, N., Ritchie, J., Aylett, R., Stanescu, I. A., Roceanu, I., Martinez-Ortiz, I., & Moreno-Ger, P. (2013). Strategies for Effective Digital Games Development and Implementation. In Y. Baek, & N. Whitton (Eds.), *Cases on Digital Game-Based Learning: Methods, Models, and Strategies* (pp. 168-198). Hershey, PA: Information Science Reference.

McGonigal, J. (2008). Reality is Broken: Why games make us better and how they can change the world. London. Jonathan Cape.

Mitgutsch, K. & Alvarado, N. (2012): Purposeful by Design. A Serious Game Design Assessment Model. FDG 2012, FDG '12 Proceedings of the International Conference on the Foundations of Digital Games. ACM New York, NY, USA p. 121-128.

Piaget, J. (1970). Science of education and the psychology of the child. Trans. D. Coltman.

Pulman, A., & Shufflebottom, M. (2009). A virtual infection control simulation: The development of a serious game in the health care sector. In Petrovic, O., & Brand, A. (Eds.), Serious games on the move. London, UK: Springer. doi:10.1007/978-3-211- 09418-1_3

Ramadan, R. and Widyani, Y. (2013). Game development lifecycle guidelines. In proceedings of the International Conference of Advanced Computer Science and Information Systems (ICACSIS), 28-29 Sept. 2013, PP 95-100. IEEE. DOI 10.1109/ICACSIS.2013.6761558

Rooney, P (2012) 'A Theoretical Framework for Serious Game Design: Exploring Pedagogy, Play and Fidelity and their Implications for the Design Process' International Journal of Game-based Learning, 2 (4) 41-60. DOI: 10.4018/ijgbl.2012100103

Ryan, J. & Dunn, P. C. (1979). "Sex education from prospective teachers' view poses a dilemma," The

Journal of school health, vol. 49, pp. 573-5

Schuler, D. Aki Namioka, eds.(1993), Participatory Design: Principles and Practices. Hillsdale, NJ: Lawrence Erlbaum Associates. Schuler Participatory Design: Principles and Practices.

Vorderer, P. & Bryant, J. (2006). Playing Video Games: Motives, Responses, and Consequences. Routledge.

Vygotsky, L. S. (1980). Mind in society: The development of higher psychological processes. Harvard university press.