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A Concurrent Think Aloud Study of Engagement and Usability in a Serious Game

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Abstract. This research presents a think-aloud study intended to examine different issues of engagement and usability in relation to a serious game and a more traditional online program. Results from twenty concurrent think aloud sessions involving a serious game called Shadow and its more traditional counterpart called SHADE are reported. Both programs are designed to help counsel young adults with depression and alcohol or other drug issues. An analysis of the think aloud results reveal issues related to both usability and engagement with users' concerns cycling between content or operation of the interface. The main themes emerging from the study provide an alternative design lens for creators of serious games.

Keywords: Engagement • Serious Games • Think Aloud • Usability • Design

1 Introduction

The study of serious games has been ongoing since its inception in 1970 [1]. A motivation to developing serious games is the idea that they are in some way engaging, perhaps more so than other approaches, and this higher level of engagement can help improve the intended outcomes [2,3]. Unfortunately, the term itself is often used without clear definition, which can lead to difficulties when it comes to measuring how engaged one is with an activity. Indeed, engagement is a complex concept, encompassing varying components. This paper will begin with a brief discussion of the concept of engagement, describing three key types of engagement, cognitive engagement, behavioural engagement and affective engagement.

The paper will go on to describe a study into issues related to usability and engagement, in a project designed to compare a traditional online psychological treatment program, called SHADE [4], with a serious game called Shadow [5], which has been designed as a game version of the more traditional SHADE program. In both cases these programs are designed to assist in the treatment of young adults with comorbidity of

depression and alcohol or other drug issues. Previous work related to this study has been reported elsewhere [4,5,6,7]. In this paper we will provide a brief introduction these programs to provide context for our study.

The main intention of the paper is to report on outcomes from study examining usability and engagement issues with both SHADE and Shadow using concurrent think-aloud. Results from twenty think-aloud sessions are examined and analysed using a framework analysis [8,9] into a number of key themes. These themes are discussed in relation to both SHADE and Shadow with differences between the traditional approach and serious game approach being highlighted. The themes emerging from the study are also relevant for designers of serious games who may wish to have an alternative lens on usability and engagement.

2 Concepts of Engagement

In simple terms, engagement refers to a person's involvement in a specific activity. Stemming from examinations on pupil engagement in school-work [10], one succinct description of engagement suggests it is "a complex meta-construct with behavioural, affective and cognitive components that vary both situationally and dispositionally" [11]. The concept of engagement in interface design has further been related to the notions of immersion, presence, flow and absorption [12]. Presence relates to how aware the user is of their real world environment while also feeling or present in the virtual one [13]. In terms of gaming, an immersive experience relates to the game's capacity to induce the feeling of actually being a part of the game environment [14].

The two concepts of presence and immersion are often used interchangeably in the literature. However a key distinction lies within how actively game content is experienced [15]. Immersion is a process through which one becomes deeply involved in the material, gameplay or story. Presence can then be seen as playing a part in inducing immersion. Both presence and immersion might be experienced in other, less interactive media, such as books, music and film. By contrast engagement implies a more active participation with the material [15], The active engagement with material, whether solving puzzles, understanding concepts or overcoming challenges [15] links directly to the design of user interactions within video games.

The immersive and engaging capabilities of video games can lead the player to experience what is described as the 'Flow' state [16]. It is generally agreed that the concept of Flow is an identifiable and key element in the concepts of engagement and immersion. The Flow state is referred to, in common vernacular, as the feeling of being "in the zone", with a limited awareness of one's surroundings as attention is given entirely to the focus of the activity. The Flow state is an intrinsically rewarding state of extreme concentration or absorbed focus potentially leading to being unaware of the passage of time. Achieving the Flow state, combined with challenge, progression, and skill, can result in an optimal experience [17,18,19]. These optimal experiences might be considered fun, and intrinsically motivating, when a balance can be achieved between the challenge of the game and the skill of the player [19].

On analysis of the various uses of the terms in the literature we differentiate engagement into three components, “Behavioural Engagement”, “Affective Engagement” and “Cognitive Engagement”. This allows for more targeted measurement of the different aspects of engagement and also suggests a variety of approaches that help quantify these aspects of engagement.

Behavioural engagement is defined as focused activity on a task, with a typical measurement being time on task [20]. Behavioural engagement might thus be influenced by both motivational characteristics of situation and personality.

Cognitive engagement we define as mental activity associated with presented content, and is measured by successfully achieving the desired goal of the game, or by pre and post testing of outcomes. Other, more objective, tests related to physiology, such as eye-blink and scanning, have also been suggested to measure this aspect of engagement [18]. Once again individual characteristics might impact on this type of engagement and dynamic difficulty [11] approaches have been used to try and ensure challenges meet the player's changing ability levels. This a key relationship often attributed to players being in a high zone of performance.

Affective engagement relates to emotional responses of players to game content. Affect is in itself a complex concept, further differentiated into emotion, cognitive and affective processing elements [21]. Affective processing might be measured in response to a simple emotional cue, and can be positive or negative. More complex emotional states such as curiosity, fun [22], interest and excitement can be measured using more traditional subjective feedback [11] or approaches such as think aloud [23]. Quantitative measures of Affect in interface design focus on determining valence and arousal. In simple terms, valence refers to the positive or negative nature of the affect, and arousal refers to the intensity of the affect. Typically valence is objectively measured using the Startle probe [24] while arousal is measuring using a range of objective physiological measures such as skin conductance or heart rate that are known to vary with changes in arousal [21].

3 SHADE and Shadow

SHADE is a web-based intervention program for helping to treat binge drinking and depressed mood [4]. SHADE consists of information and interactive components, including case vignettes and in-session exercises. It provides tips for reducing alcohol consumption and improving mood. In this study the focus was on the “Mood Monitoring” and “Taking Charge of Your Thoughts” module of the SHADE program. This module uses cognitive behavior therapy (CBT) and motivational interviewing techniques to encourage behavioral and cognitive change related to a person’s mood, and misuse of alcohol/other drugs. While the SHADE program has demonstrated efficacy in reducing depression and alcohol use over time [4], treatment completion rates are 36%, with average attendance at 5-6 out of the full 10 sessions. Sessions 5-6 within the SHADE program correspond to a move from behavioral tasks to more complex cognitive strategies, which seem to be difficult to relay in the more traditional interface style used with SHADE.

Shadow is a serious game prototype, developed from SHADE that uses a more traditional, didactic approach for psychological counseling. To try to improve completion of the SHADE program, and the ability to encourage program users to understand the cognitive tasks associated with SHADE treatment, the serious game prototype called Shadow is being developed and evaluated as an alternative teaching method [5].

Shadow provides game players with several scenarios requiring successful navigation using a range of CBT techniques [4]. An additional interactive component of the game, focusing on "Mindfulness" allows players to manage their thoughts and control their mood by categorizing harmful thought patterns. These strategies are characteristic of the cognitive tasks associated with typical CBT programs, and the SHADE computer program in particular.

4 METHOD

Ten participants, 5 male and 5 female, within the ages of 18-30 were recruited for the study using poster and word of mouth. The participants consisted primarily of students at the University of Newcastle. No history of depression or substance abuse were required for participation, however participants were screened for suicide risk with provision of crisis information if required. Participants were required to have normal or corrected to normal vision. All participants were informed through a participation information statement about the intention and methods to be used in the experiment. All included participants completed two phases of the experiment, an evaluation of Shadow and an evaluation of Shade. These evaluations were carried out in two separate sessions at least a week apart. The order of evaluation was randomised with five participants experiencing Shadow, the game, followed by SHADE, the online program. The other five participants experienced SHADE first followed by Shadow.

The evaluation process was complex with a range of measures being taken including Startle reflex modulation [25] and think-aloud [23] over a 10 minute period. At the conclusion of each condition participants were asked to complete three questionnaires. Two of these were standard interface usability assessments, the System Usability Scale [26,27] and an adapted Perceived Usefulness survey based directly on the Perceived Usefulness and Ease of Use survey [28]. The third was a specially designed survey typically used to profile behaviour measuring different aspects of user engagement [12]. Results of the startle reflex and survey responses are discussed elsewhere [6,7].

Think-aloud is a method of recording data in the form of verbal reports from participants during specific conditions, which can be completed during a task or immediately after [23], [29]. In this study, participants were asked to verbalise their thoughts during the 10 minute sessions and were introduced to the think-aloud activity during a practice session prior to recording. This approach of concurrent think-aloud is in keeping with recommendations for improving validity of verbal protocol analysis [23]. Concurrent think aloud is considered able to elicit a more pure representation of participants' cognitive activity and focus than retrospective think aloud. Video recordings of the 10 minute sessions were later transcribed by the research team for further analysis. Transcriptions of the 20 think-aloud sessions (10 for SHADE and 10 for Shadow) were analyzed

using an approach described as framework analysis [8,9]. The transcription data were segmented into individual utterances involving an iterative process of revision of the coding framework and consultation between research members.

5 Results

Across all 20 transcripts, a total of 15601 utterances were identified and analyzed using two specific coding frameworks based on location and participant utterances. Dual coding frameworks were used to allow comparison of interaction forms differentiated between passive elements (reading) and participatory elements (problem solving and decision making). The first framework consisted of 10 codes based on location in the game or program. For example, Introduction, Instructions, Dialogue, Mindful Mode, Activity Sheets, and Content/Main areas. The location framework allowed grouping of utterances within areas defined by dominant interaction forms. The second framework used 41 codes based on participant utterances. This framework included participant utterances or audible interaction events (clicks) related to their activities within the program, or the operation or components of the programs themselves.

The codes from the second framework were summarized into eight relevant themes (see table 1) related to the game or program content or were helpful in understanding participant reactions or thought processes. From these eight themes, four meta-themes were derived from the perspective of participants' experiences (see table 1). Next we discuss results for each meta-theme in relation to usability and engagement in both SHADE and Shadow.

Table 1: Emergent Themes and Meta Themes from Think Aloud Study

Meta Themes	Component Themes
1. I'm trying to do this.	1.1 Frustration/Confusion with the game/program. 1.2 Reflections of own action or experience. 1.3 Development of understanding.
2. I'm interested in doing this.	2.1 Connection with the game/program. 2.2 Response to game/program event.
3. I want to progress.	3.1 Interacting with the game/program. 3.2 Comments on presentation of game/program.
4. I'm able (or not) to do this.	4.1 Progression through the game/program.

6 Discussion

6.1 Meta-Theme 1 - I'm trying to do this.

The first meta-theme, "I'm trying to do this", was derived from participant utterances conveyed a sense of their attempts to understand the task. This meta-theme encompasses the themes of Development of understanding, Reflections of own action or experience in/of the game or program, and Frustration or confusion with game or program.

Development of understanding covers utterances indicative of a development of understanding, or desire to understand. This understanding concerns how the game or program works and what the content is telling the participant. Participants demonstrated an understanding through utterances reflecting anticipation, a sense of having discovered an answer (eureka), clarification of unclear material, affirmations of having understood, elements of testing (problem solving), comments about dialogue or how the game or program works (mechanics), and a viewing of the bigger picture (self-reflection external).

- "aah meant to match the correct things" (P005, Shadow)
- "that's negative conclusive.. no umm probably so it's catastrophising" (P012, Shadow)
- "just people... possible... lots of blaming happening here isn't there" (P010, SHADE)

Reflections of own action or experience in/of the game or program encompasses utterances indicative of the participant stepping back from the story or task. This stepping back retains the focus within the game or task. In trying to do this, participants examine their performance of tasks within the programs. These reflections indicate the game or program changing in response to participant actions (feedback) or the participant actions themselves (self-reflection internal).

- " / um now I don't know what I'm talking about" (P008, Shadow)
- "click to continue and it moves" (P009, Shadow)

Frustration or confusion with game or program covers utterances indicating difficulties in operating or understanding the programs. Frustration or confusion were seen in verbal cues such as sighs and rapid, focused clicking (multiple clicks). The attribution of frustration or confusion to these utterances was made after consideration of adjacent utterances.

- "I'll be such a loser... god dammit ... umm black - catast-catastro like" (P006, Shadow)

All participants contributed utterances to this meta-theme. The participant experience of this meta-theme is represented across both SHADE and Shadow, however the participant experience differs across locations In SHADE these utterances related to

program locations requiring reading or the absorption of information. Conversely in Shadow, these occur in game locations relating to puzzle solving and decision making.

For most participants, the usability of both SHADE and Shadow were sufficient to allow participants to engage in the content with minor interruption. This meta theme, “I’m trying to do this” reveals users attempt to learn the program functionality and to further engage in the program experience. It demonstrates participants recognise their own ability and have a self-awareness of when they don't understand. This awareness provides opportunity for them to explore other options. The frustration or confusion felt by participants when they don't understand can provide an indication of emotional investment in successfully completing the task.

Meta-Theme 2 - I'm interested in doing this

The second meta-theme, "I'm interested in doing this", describes utterances related to behavioural engagement, indicating how interested or invested a participant is in the content, or their desire to know more. This meta-theme encompasses the themes of Connection with the game or program and Response to game or program event.

Connection with the game or program consists of utterances indicating the participant is connecting with the program or game content. This was seen in verbal cues and utterances related to empathy, positioning themselves in the game or program's setting, the projection of values onto game or program content, or comments about the game or program's story or characters.

- "I wanna play" (P012, SHADE)
- "I wouldn't really do any of those things" (P007, Shadow)
- "they probably didn't hear me, or if they did they're an *&%$#-!or maybe they're busy or something" (P006, SHADE)

Response to game or program event covers utterances of participant reactions to events in the game or program. Participant responses indicative of Affective engagement included responses such as laughter, celebratory statements, or an expression of surprise or disappointment. The attribution of surprise, delight, disappointment or celebration to these utterances were made after consideration of their context.

- "awww so many - uh words" (P003, SHADE)
- "let's go ooh it moves" (P009, Shadow)

All participants contributed utterances to this meta-theme. In this meta-theme, participant experience of SHADE and Shadow differed. While all participants presented cues for the game, four participants presented no utterances describing a connection with the more traditional SHADE program. For Shadow, utterances related to a connection with or response to the game or program predominantly emerged from locations involving decision-making and puzzle solving. In SHADE the utterances emerged from locations where reading was the dominant mode of user interaction with the program. The less interactive nature of SHADE's reading may assist in understanding why four participants made no utterances of connection with this program. This meta-theme also

provides evidence about a participants' interest in engaging with or continuing the experience revealing desire to know or explore more of the content.

Meta-Theme 3 - I'm able (or not) to do this

The third meta-theme, "I'm able (or not) to do this", covers the themes of Interacting with the game or program, and Comments on presentation of game or program. This meta-theme describes utterances stemming from a participant's physical activity in relation to the interface and the participant's comments about its presentation.

Interacting with the game or program encompasses how participants interact with the game or program. In being able or not to do this, participants would utilise program controls to access content. The theme consists of utterances representing participant actions within the interface (clicking or dragging), the absorption of information (reading or paraphrasing), or the informed application of material and interaction (navigation or writing).

- "ah, my value as a person depends on what they think of me or pleasing other people is more important to me than pleasing myself" (P005, SHADE)
- " if the text is faded grey, the option is not available and you'll need to adjust the mood " (P007, Shadow)
- " thoughts change mood, mood determines events, mindful mode changes mood" (P003, Shadow)

Comments on presentation of game or program encapsulates utterances focussing on the interface interactions or presentation of the interface. This theme describes participant comments on the look and feel (aesthetic), interactive elements of the interface, transitions between scenes (motion), and the logical structure and display of information.

- "I like the illustration" (P011, Shadow)
- "that's a really giant chunk of text" (P010, SHADE)
- "oh, exit button at the top right" (P004, SHADE)

All participants contributed to this meta-theme of "I'm able (or not) to do this". All participants evinced at least one utterance for each of the two themes relating to presentation of information and interaction with the game or program. The participant experience represented by this meta-theme was shared between SHADE and Shadow. However there are more recorded utterances of interaction in the Shadow game than the SHADE program. The appearance of utterances based on program location follow the cognitive engagement pattern demonstrated in the previous meta-themes. More utterances related to the activities of reading occurred during SHADE sessions, and in Shadow the activities of puzzle solving and decision-making emerged as the dominant elements of the user experience.

This meta-theme evidences participants' actions in the programs; what they did and how they did it. Interaction with the programs demonstrated how the programs were

operated and the information sources participants used to develop understanding. Comments on presentation identified participant's awareness of and ability to identify the affordance of interface elements. This meta theme gives some insight into the participant's appreciation of the interface aesthetics, or helps identify where the aesthetics distracted from the content.

Meta-Theme 4 - I want to progress

The forth meta-theme, "I want to progress", describes utterances representing the participants' ability and / or desire to progress through the game or program. The single theme, Progression through the game or program, covers utterances related to this meta theme. In wanting to progress, participants would act on a desire to get further through the program. Progression includes decisions or difficulties with the process of progression.

- "I'm stuck" (P008, Shadow)
- "wow, this wasn't where I was... it's probably where I should have started I guess" (P004, SHADE)
- "I'm going to the *click* instructions" (P011, Shadow)

All participants contributed utterances to this meta-theme. The participant experience related to this meta-theme was represented in both SHADE and Shadow, with the exception of one participant in their SHADE session who made no comment on progress. Like the other meta-themes, utterances representing progress emerged from consistently different locations between Shadow and SHADE. Within Shadow, utterances emerged from the locations associated with puzzle solving and decision-making. Within SHADE, these emerged from locations associated with reading.

This meta-theme evidenced participants' desire to navigate around and continue through the programs, and the decisions made to overcome challenges. Progression indicated where in the program the participant was intending to reach and where they were stuck. Overall, this meta-theme provides further indication of the participants cognitive and affective engagement.

6.5 Further Discussion

Think aloud further revealed key differences between Shadow and Shade. Shadow provided participants agency over the progression of the game; this active participation elicited utterances associated with both affective and cognitive engagement. For examples, puzzle solving elements unique to Shadow presented more 'eureka' moments of delighted understanding. Participants nonetheless indicated signs of cognitive engagement with the more passive presentation of SHADE's content, though comments regarding the wordiness of its content were frequent.

The commonality between participants' usage of SHADE and Shadow was the cyclic nature of the meta-themes. Participants would attempt to use the programs, and in so doing become interested and invested in their activity. This interest lead to a desire to

progress. The participant's ability to use the program, or from their perspective if the program allowed them to progress, then became the crux of this cycle. If participants encountered difficulties with the program operation, whether through usability issues or a lack of contextual understanding, they would break out of a focus on content and instead focus on the workings of the program. Once the program operation was understood, the focus shifted back to engagement with content. This cycle occurred in every session, and all participants finished in the content cycle having shifted to program operation at least once.

Table 2: Mapping of Themes to Engagement Type

Engagement Type	Theme
Affective	Frustration/Confusion with the game/program. Connection with the game/program. Response to game/program event. Progression through the game/program.
Cognitive	Reflections of own action or experience. Development of understanding. Response to game/program event. Interacting with the game/program. Comments on presentation of game/program.
Behavioural	Reflections of own action or experience.

Furthermore, the themes emerging from the data can be loosely mapped to engagement types (see Table 2). Affective engagement was primarily seen within the themes tied to emotional responses, whether involuntary sounds or comments directed at characters within the programs. Cognitive engagement was mostly seen within themes related to problem solving; learning the program, understanding the mechanics, and generating understanding. Behavioural engagement could be inferred from reflective comments, however true measures of behavioural engagement may only become apparent over time, particularly in terms of desired behavioural outcomes tied to the serious game or in terms of engagement with the program.

7 Conclusion

The intention for this study was to understand any difference in engagement between serious games, like Shadow, and more traditional interfaces in programs like SHADE. We also hoped to determine if fundamental usability differences between Shadow and SHADE might impact engagement moreover than game-like features unique to Shadow. The meta themes representative of this cycle, the attempt to use, interest in the programs, desire to progress, and the ability or not to operate the program may present

potentially useful lenses to understand the interplay of usability and engagement in serious games.

Each program presented minor issues with usability, including display errors, complex navigation and progression walls. These issues were found to trigger shifts in focus, but not necessarily break engagement as participants were engaged with working out the program rather than with content. The purpose of serious games is often focussed on improving learning, training or therapeutic outcomes. Barriers to progression or usability issues, while beneficial to reduce, may be deliberately leveraged to step participants out from intense focus on content and allow contextualisation of the serious game purpose.

The think-aloud method provided immediate, actionable feedback on user-centred aspects of a game design. This revealed which components drew player's attention, where they got stuck and how they overcame challenges.

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