PhD Thesis Excerpt

Design Principles

Here I state the design principles that have arisen as a result of this work. The following design principles will be of interest to makers of educational environments and digital contexts more generally:

1. Using avatars that **resemble users when they are doing well, and appear more minimally or abstractly otherwise**, is encouraged whenever possible. The research in this dissertation, which defines these as *successful likeness* avatars, has shown that they result in improved user performance and engagement [13]. For example, applied to a mail client or a social network like Facebook, your icon would change between a likeness of yourself or abstract depending on the positivity of your news feed, or a message you received. The essence of this principle is selectively promoting detachment and identification at key moments of the digital experience.

2. Using avatars that **resemble role models** is encouraged whenever possible. The research in this dissertation has shown that role model avatars increase both the engagement and performance of users [10–12, 17]. For example, playing as an admired and positively influential scientist, politician, business person, artist, or doctor depending on context. The criteria for an effective role model is perceived competence, similarity, and success, therefore role models should represent successful figures with demographic overlaps with users.

3. Use **embellishment** with trade-offs in mind. The research in this dissertation has shown that embellishment increases engagement, but decreases performance and self-efficacy [16]. For example, in an educational context, embellishment can be reduced to promote performance and self-efficacy, while in an entertainment context embellishment can be used more liberally.

4. Using **positive or neutral encouragement** is encouraged whenever possible. The research in this dissertation has shown that positive (e.g., "Keep it up!", "Don't give up!", "You're almost there") and neutral (e.g., "You are doing standard work", "You're doing average", "You're doing typically") encouragement text increases engagement [15]. For example, encouragement text can be spoken by a game character, or simply appear at the bottom of the screen periodically.

5. Promoting **avatar identification** is encouraged whenever possible. The research in this dissertation has shown that avatar identification promotes higher engagement, self-efficacy, time spent, and even quality of created artifacts [17]. For example, giving users the ability to customize their avatars is one simple way of increasing identification.

In the remainder of the thesis you will read about the work that led us to these principles.

Findings Summary

Here, I summarize the notable findings from our experiments: (for a more thorough breakdown of the data, see the Experiments Overview chapter):

Avatar-Based Outcomes:

- **Simple avatars often outperform complex avatars** [13]. This could be for a number

of reasons. Seductive details [5], e.g., more complex, more embellished, etc. can be a distraction, outcome dissociation [13], e.g., non-human avatars promote less identification with failure, stereotype threat mitigation [32], e.g., simpler avatars contain fewer salient identity characteristics, and the Uncanny Valley, e.g., "almost" human avatars elicit revulsion [25].

- **Scientist role model avatars are extremely effective** [10–12]. Within a CS programming environment, all participants experience increased engagement while using scientist role model avatars, while female participants experience the most significant increases. Female participants often have significant increases in their play performance and reported engagement through using a well-known scientist as their avatar (e.g., Marie Curie), as compared to participants that used a well-known athlete as their avatar (e.g., Serena Williams), or a simple abstract shape (e.g., Triangle).
- **Successful likeness avatars can likely outperform any existing avatar types** [13]. We have discovered a new type of avatar, what we term the *successful likeness*. This is a simple abstract avatar when the user is in the trial-and-error process and a likeness of the user only when the user achieves a goal. Compared to users that used only an avatar that was always simple abstract, or always a likeness of the user, or a likeness of the user when the user was in trial-and-error and a simple abstract avatar upon achieving a goal, these successful likeness participants played significantly longer and completed significantly more levels. We propose that these results can be explained by a model in which identification facilitates vicarious outcomes, and in which detachment facilitates outcome dissociation [13].
- **Red avatars cause significant decreases in engagement and avatar affect compared to blue avatars** [14]. Research has consistently shown that red reduces mood, affect and performance in cognitive-oriented tasks [4, 6, 7, 9, 20–23, 31]. For example, Lichtenfeld et. al showed that even just peripherally noticing red (e.g., hidden in a question, in the copyright notes at the end of a page, etc.) can have similar effects [21]. Prior work on first-person shooter (FPS) multiplayer games have hypothesized that blue teams are at a disadvantage because they "see red" [8]. We provide the first study to show that this effect is true in a single-player context [14]. This red-blue

discrepancy was higher for male players than for female players.

- **Badges and avatar identification promote positive outcomes** [17]. We have found that badges can promote avatar identification (personal interest, role model), player experience (achievement, role model), intrinsic motivation (achievement, role model), and programming self-efficacy (role model) during both game play and game making. Independently of badges, avatar identification promotes player experience, intrinsic motivation, programming self-efficacy, and the total time spent playing and making. Avatar identification also promoted other meaningful in-editor activity, such as playtesting time, etc. and led to significantly higher overall quality of the completed game levels (as rated by 3 independent externally trained QA testers) [17].

Other Outcomes:

- **Positive and neutral encouragement text displayed at regular intervals (e.g., "Keep it up!"), significantly increases engagement as compared to no text or negative encouragement text** [15]. Encouragement is different from feedback, in that it does not necessarily encode information about performance [18, 24, 26, 29]. Regularly dispensed encouragement, operationalized as text appearing at the bottom of the screen—both positive (e.g., "You're doing good") and neutral (e.g., "You're doing average") significantly increased player engagement as compared to negative (e.g., "You're doing badly") or none.
- **More embellished game backgrounds cause players to have significantly decreased game performance and significantly decreased programming self-efficacy but significantly increased engagement** [16]. Research suggests that the addition of seductive visual details in video games hinders performance of learners [5, 28, 33]. Yet, other research results propose the opposite: that visual embellishments and well-designed ambiguity instead improve learners' performance, engagement, and self-efficacy [30, 34, 36]. To shed light on this apparent contradiction, we implemented the following four game themes: 1) *Generic* theme with no embellishments (simple flat color background), 2) *Fantasy* game theme (forest, snow, and desert adventure backgrounds), 3) *STEM-oriented* theme (computer circuitry background),

and 4) *Choice* (the user picks one of the previous three options). Generic condition participants had highest performance (levels) and had highest programming self-efficacy—followed by choice, fantasy game setting, circuitry. However, ordering of conditions for engagement was precisely opposite the trend for performance. These are trade-offs between two diametrically opposed approaches to game themes and embellishment: instrumental game skins vs. thematic and deliberately embellished game skins [16].

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