Enabling Critical Self-Reflection through Roleplay with Chimeria:Grayscale

Pablo Ortiz
MIT
Cambridge, MA
portiz@mit.edu

D. Fox Harrell
MIT
Cambridge, MA
fox.harrell@mit.edu

ABSTRACT

The human-computer interaction (HCI) field includes a long-standing community interested in designing systems to enable user reflection. In this work, we present our findings on how interactive narratives and roleplaying can effectively support reflection. To pursue this line of inquiry, we conducted an exploratory, cross-sectional study evaluating an interactive narrative we created, *Chimeria:Grayscale*. To address issues present in prior HCI studies on the topic of reflection, we grounded our system design methodology and evaluations in theories drawn from clinical psychology and education. The results of our study indicate that *Chimeria:Grayscale*, the interactive narrative we created by operationalizing our system design methodology, enabled our study participants to critically self-reflect.

CCS Concepts

•**Human-centered computing** → **Human computer interaction (HCI);** •**Applied computing** → *Law, social and behavioral sciences;* •**Information systems** → Multimedia information systems;

Author Keywords

interactive narrative; learning; reflection; roleplay

INTRODUCTION

As a design outcome, reflection has garnered significant academic interest over the years. The resulting body of research spans a diverse set of application areas including: personal informatics [8, 27], health [28], and education [34].

In this work, we present our findings on how interactive narratives and roleplaying can effectively support reflection. To pursue this line of inquiry, we conducted an exploratory, cross-sectional study evaluating an interactive narrative we created, *Chimeria:Grayscale* [22]. *Chimeria:Grayscale* seeks to enable users to critically self-reflect on issues of sexism in the workplace by having them roleplay as a newly hired employee at a toxic workplace. To evaluate our interactive narrative, we conducted an exploratory, cross-sectional study during which participants (N=31) experienced *Chimeria:Grayscale*, and, afterward, completed a survey. The results of this study suggest that *Chimeria:Grayscale* enabled our study participants to critically self-reflect on the themes of the narrative.

Despite the centrality of reflection to prior HCI studies on the topic, designs theoretically grounded in cognitive or learning sciences are largely absent from the literature. For the most part, prior work has relied on the implicit assumption that, "by providing access to data that has been 'prepared, combined, and transformed' for the purpose of reflection, reflection will occur" [5]. Not only does this assumption lack a theoretical basis, its direct application to a system design may lead users to experience the backfire effect [33], a phenomenon where a person presented with counter-attitudinal evidence outright rejects this evidence and adheres more strongly to their current beliefs. Prior studies have also struggled with the evaluation of reflective outcomes [5]. Without a clear theoretical framework, it is difficult to precisely identify reflection in others. Furthermore, this lack of precision makes comparing results between published works a challenging exercise.

To address these issues in our work, we grounded our system design methodology and evaluations in theories drawn from clinical psychology and education. Though we also drew from other sources, our work was primarily informed by Yardley-Matwiejczuk's roleplay induction principles [43] and Mezirow's *Transformative Learning Theory* [30]. The former offers guidance on designing effective roleplays and, the latter provides a concrete method for evaluating reflective outcomes.

The rest of this paper is organized as follows. We summarize related literature, introduce our theoretical framework, and provide a case analysis of *Chimeria:Grayscale*. We conclude by presenting and discussing the results of our user study.

RELATED WORK

This section summarizes related literature on reflection, roleplay, and games.

Reflection

Fleck & Fitzpatrick [12], Baumer et. al. [5], and Baumer [4] have each published excellent overviews of the work on reflection conducted within the academic HCI community. As such, we shall not reproduce those works here. Instead, we shall focus our discussion on individual research efforts with aims similar to our own.

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than the author(s) must be honored. Abstracting with credit is permitted. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from permissions@acm.org.
CHI PLAY '18, Oct 28–31, 2018, Melbourne, QLD, Australia
Copyright is held by the owner/author(s). Publication rights licensed to ACM.
ACM ISBN 978-1-4503-5624-4/18/10…$15.00
https://dx.doi.org/10.1145/3242671.3242687

With few notable exceptions, published HCI research related to reflection pays little attention to the important task of scaffolding the reflection process. This, in our opinion, is an oversight given the significant effect scaffolding has on reflective outcomes. As stated by Slovák et. al. [41] in their work on developing a framework of sensitizing concepts for designing technologies that support reflection, there is a "need to scaffold the reflection process, rather than assuming the ability to reflect is a trait that can be readily triggered by providing the relevant information." Further, they demonstrate this need through the analysis of two case studies.

MAHI [28] is an example of a system that scaffolds the reflection process by design. The goal of this health-monitoring application is to help individuals newly diagnosed with diabetes to acquire the reflective thinking skills required for managing their condition. To meet this goal, MAHI provides users with on-demand access to diabetes educators willing to guide them to reflect meaningfully on behaviors recorded by the system. Over time, users who make use of this service learn how to reflect on their own behavior without guidance, thus, realizing the intent of the designers. Mamykina et al. included the service in the design of MAHI for the express purpose of scaffolding the reflection process.

More recently, Saksono et. al. [38] investigated how storytelling and reflective prompts can effectively support reflection for families with young children. As part of a theoretically grounded study evaluating this approach, parents and their children engaged with a low fidelity prototype based on a story book for children. Reflective prompts and parents both played a part in scaffolding reflection throughout the study. Results revealed opportunities and challenges within story-driven, wellness-centered family reflections.

Roleplay

Educators sometimes employ roleplay[1] as a pedagogical tool for helping students acquire a deeper understanding of subject material. To use roleplay effectively, educators must understand their students' dispositions and carefully design roleplay scenarios with that information in mind. With proper preparation, roleplays enable students to engage with and reflect on related subject material both during and after the experience. Through this reflection, students achieve the desired learning outcome: an improved understanding of the subject material.

Roleplay has been used in this way to educate students from a wide range of disciplines. For example, in their working paper on negotiation pedagogy, Susskind and Corburn [42] provide an overview of their approach to designing and conducting roleplays that enable students to reflect on their negotiation skills and, thereby, improve them. Similar guidelines have been published for teaching communication skills [23], international relations theory [1], urban planning [37] and more.

Games

The terms *serious games*, *games for change*, *impact games*, and more have all been used to describe games designed for a purpose other than entertainment. *Chimeria:Grayscale* exists within this milieu. Because none of these labels completely captures our aims in designing systems for reflection, however, we prefer to describe it as an epistolary, interactive narrative[2] that addresses issues of sexism in the workplace. While there has been substantial debate about both the nomenclature and best design practices for such games, there is little debate that creating such systems is a vital and growing area.

Though lacking theoretical grounding in theories on reflection or roleplay, there are some notable examples in the literature of games with goals or methods similar to those of *Chimeria:Grayscale*. These include *Time Mage* [44], a game designed to promote patient self-efficacy during hospital stays, and *Missing: The Final Secret* [3], a game for teaching players how to recognize and curtail their cognitive biases. Our previous works, *Mimesis* [21], a game that explores themes related to racial discrimination, and *Chimeria:Gatekeeper* [19, 20], a game that explores themes related to impression management and social stigma, also have similar reflective aims to those of *Chimeria:Grayscale*.

THEORETICAL FRAMEWORK

At a very high level, the theories and methods described in this section were all employed in this study in service to the creation and evaluation of a high quality roleplay experience as would be judged by experts in the fields of education and clinical psychology. In doing so, we sought to produce one of the primary outcomes of successful educational and therapeutic roleplays: reflection.

Critical Self-Reflection

As noted by Baumer et. al. [5], few papers in the HCI literature provide an explicit definition of reflection to readers. Those that do tend to cite Schön's reflection-in-action and reflection-on-action [40].

In this work, we depart from tradition by adopting Mezirow's notion of *critical self-reflection*. This notion is perhaps best understood in the context of Dewey's definition of reflection. Dewey [10] defines reflection as "active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it, and the further conclusions to which it tends." Building on this definition, *critical self-reflection* can be defined as a type of reflection characterized by an individual's reexamination of the presuppositions that inform their own beliefs, thoughts, and actions. [30]

Our motivation for grounding this work in Mezirow's notion of *critical self-reflection* is twofold.

First, although not addressed in our study, we are interested in the potential of reflection for effecting conceptual change. *Transformative Learning Theory* [29, 31, 32] describes a process driven by *critical self-reflection* whereby an adult's presuppositions change to accommodate new information or perspectives. During the multiple stages of this process, shown in Figure 1, an individual reflects on a fundamental challenge

[1]The terminology around roleplay varies by discipline. Some disciplines use the word *simulation* instead of roleplay.

[2]We also describe *Chimeria:Grayscale* as a critical-computational system to better communicate its goal of social critique through reflective engagement. [17]

1. A disorienting dilemma
2. Self-examination with feelings of fear, anger, guilt, or shame
3. A critical assessment of assumptions
4. Recognition that one's discontent and the process of transformation are shared
5. Exploration of options for new roles, relationships, and actions
6. Planning a course of action
7. Acquiring knowledge and skills for implementing one's plans
8. Provisional trying of new roles
9. Building competence and self-confidence in new roles and relationships
10. A reintegration into one's life on the basis of conditions dictated by one's new perspective

Figure 1. Stages of *perspective transformation* according to Mezirow.

to their existing presuppositions. At the end of this transformative process, an individual may abandon their former presuppositions in favor of new insights or synthesize new presuppositions from insights both new and old. Mezirow refers to the conceptual change brought about by this process as *perspective transformation*.

Second, we wanted an effective way of assessing user reflection enabled by *Chimeria:Grayscale*. As noted by Baumer [4], evaluating an individual's reflective experience is challenging. Typically, quantitative and qualitative assessments of reflection in the HCI literature do not involve direct measurements of reflection. Instead, these assessments treat other, more easily measured outcome variables as indicators of the quality or quantity of reflection experienced by study participants. As stated previously, these works tend to not provide a clear definition of reflection to readers. Thus, the interpretability of results obtained by these indirect measures is questionable. By adopting Mezirow's notion of *critical self-reflection*, we are able to indirectly measure reflection via a validated survey instrument grounded in the exact same definition of reflection that we adopt in our work, namely, the Learning Activities Survey [26]. This survey instrument measures whether, and to what extent, a *perspective transformation* has occurred as a result of a transformative experience. Thus, we can use results obtained from administering the Learning Activities Survey to reason about the stages of *perspective transformation*, and, therefore, the amount of *critical self-reflection*, experienced by study participants.

Roleplay

The term *roleplay* has overlapping, but distinct, meanings in diverse areas including clinical psychology, education, games, theater, and more. While providing an exhaustive list of definitions of roleplay across fields is beyond the scope of this paper, we will highlight a few conceptualizations of roleplay related to this work from the fields of clinical psychology and education. Yardley-Matwiejczuk [43] provides us with a concise description of roleplay from the perspective of a clinical psychologist: "...roleplay or simulation techniques are a way of deliberately constructing an approximation of aspects of a 'real life' episode or experience, but under 'controlled' conditions where much of the episode is initiated and/or defined by the experimenter or therapist." Ellington et. al. [11], from the area of education research, define roleplay as, "ongoing representations of real situations." From these definitions, we observe that both disciplines position roleplay as being in dialogue with real-world phenomena. Further, both disciplines employ roleplay for similar reasons.

Roleplay is typically used in clinical settings to analyze behavior, improve skills, and generate self-understanding [9]. These practices have strong parallels with roleplay practices in education. Note that generating self-understanding, in particular, can be reframed as a form of *perspective transformation* driven by therapist-guided *critical self-reflection*. Thus, roleplay in the context of clinical psychology can be reasoned about through the lens of *Transformative Learning Theory*.

Roleplay, as a pedagogical tool, has long been used within education. When seeking to help students acquire a deeper understanding of subject material, educators may use roleplay to achieve their desired learning outcomes. Paschall [35] describes roleplay as, "a form of active learning, a type of teaching method in which students 'learn by doing' and by reflecting on what they are doing." When roleplay is used effectively, students achieve an improved understanding of subject material through reflection enabled by roleplay. Suppose that an educator established "realization of greater self-understanding" as the learning objective for their students. If that educator employed roleplay as a means of achieving this learning outcome, they would be duplicating the practice of roleplay in clinical psychology. We can, thus, view roleplay practices in clinical settings as being a special case of the more general roleplay practices employed in education.

Designing and deploying effective roleplays is challenging. A critical component of successful roleplays is the use of effective roleplay techniques. Yardley-Matwiejczuk [43] observed that the quality of a roleplay experience is affected by the quality of the procedure for inducting participants into the roleplay scenario. Effective roleplay induction increases participant engagement with a scenario and, thereby, the impact of the roleplay on participants.

Yardley-Matwiejczuk [43] identified three major roleplay induction principles in her work: *Particularization*, *Presencing*, and *Personalization*. *Particularization* is a principle concerned with the process by which all facets of a roleplay scenario that a participant should be aware of are explicitly detailed to that participant. *Presencing* is a principle concerned with the process by which all facets of a roleplay scenario are granted a degree of familiarity and reality in the eyes of the participant. *Personalization* is a principle concerned with the degree to which particularized content is drawn from the participants themselves. There are a set of design guidelines (too numerous to reproduce here) associated with each roleplay induction principle.

As stated previously, using roleplay induction technique improves the quality of roleplay outcomes. Thus, when designing *Chimeria:Grayscale*, we operationalized each roleplay induc-

tion principle. By doing so, we specifically sought to increase user engagement with our interactive narrative and, thereby, the reflective impact of *Chimeria:Grayscale* on users.

The Embedded Design Model

In their work on using games as interventions, Kaufman et. al. [24, 25] found that subtly embedding persuasive content into games was more likely to succeed in changing the attitudes or behaviors of players than presenting the same content in their games in a direct, explicit fashion. After experimenting with different strategies for embedding persuasive content into games, they identified three such strategies that both trigger more receptive mindsets and circumvent existing psychological barriers with respect to a game's persuasive content.

The three strategies, referred to together as the *Embedded Design* model, are: *Intermixing*, *Obfuscating*, and *Distancing*. *Intermixing* involves presenting a balance of on- and off-message content to make the former less overt or threatening. *Obfuscating* involves using framing devices that divert focus away from the game's message. *Distancing* involves employing fiction to increase the psychological gap between players' identities and the game's persuasive content.

By implementing the Embedded Design model in *Chimeria:Grayscale*, we sought to increase the number of users who would reflect meaningfully on the themes of our interactive narrative. Though not addressed in our evaluation, we were motivated by a desire to prevent phenomena like the backfire effect [33] from manifesting in users.

Morphic Semiotics

In the field of semiotics, signs (images, sounds, words, objects, etc. that humans attribute meaning to) have been defined as the combination of a representation, the signifier, and that which is represented, the signified [39]. Signs come in systems. To illustrate this point, consider that the meaning of hand gestures can vary by cultural context. The "thumbs up" gesture can be friendly or rude depending on the sign system. Systems of signs have also been called semiotic spaces. As in Goguen [16], we shall use this term going forward.

Morphic semiotics [15, 17] provides a formal language for describing semiotic spaces and the relationships between them. Representations of semiotic spaces described using this approach have the desirable property of being amenable to computation. Additionally, they capture the key aspects and structure of that which is being represented.

Semiotic morphisms are mappings from one semiotic space, the source space, to another semiotic space, the target space. Given semiotic spaces P_1 and P_2, a *semiotic morphism* M from source P_1 to target P_2 can be denoted as follows: $M : P_1 \rightarrow P_2$. *Semiotic morphisms* are composed of three types of partial mappings: (1) sign types from the source space mapped to sign types in the target space, (2) sign constructors from the source space mapped to sign constructors in the target space, and (3) functions from the source space mapped to functions in the target space. The key idea behind these rules is that the quality of a *semiotic morphism* is determined by how well the structure of the source space is preserved in the target space.

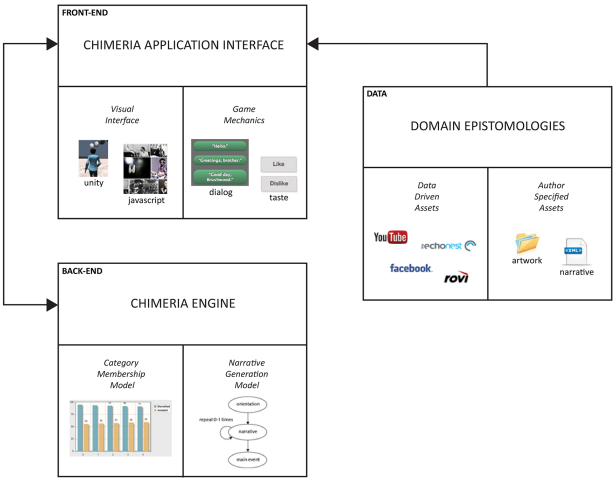

Figure 2. Example architecture of an application created using *Chimeria*

When designing *Chimeria:Grayscale*, we used morphic semiotics to precisely map the *ambivalent sexism* framework to a model implemented in *Chimeria*. Thus, we created a *semiotic morphism* from the *semiotic space* of the *ambivalent sexism* framework to the *semiotic space* of *Chimeria*. In doing so, we sought to create a tight coupling between the *ambivalent sexism* framework and the content & behavior of *Chimeria:Grayscale*

CASE ANALYSIS

This section introduces *Chimeria*, the platform upon which our interactive narrative was built, and *Chimeria:Grayscale*, the interactive narrative that operationalizes our approach to enabling user reflection.

Chimeria

Chimeria was created as part of an NSF-backed project called "Computing for Advanced Identity Representation."[3] The goal of the project was to research identity technologies that enable imaginative self-representations and counter social ills through dynamic social identity modeling grounded in computer and cognitive science. To that end, the *Chimeria* system [18, 19, 20] supports the simulation of physical-world social identity phenomena in virtual identity systems and provides tools for authoring expressive systems that demonstrate such phenomena. Its identity modeling engine can simulate agents with multiple category memberships, gradient category memberships, and dynamic category memberships.

To create a more compelling interactive experience in *Chimeria:Grayscale*, we expanded the feature set of *Chimeria*'s authoring tools to include narrative branching. Previously, the platform defined narratives as streams of events. Individual narrative events could be configured to manifest in the stream of events in a variety of ways (e.g. fixed/variable number of manifestations, conditional manifestations). With our modifications to *Chimeria*, narratives can be defined as a tree of events such that a depth-first traversal from the root node to a leaf node constitutes a complete narrative experience. We

[3]NSF CAREER Award #0952896

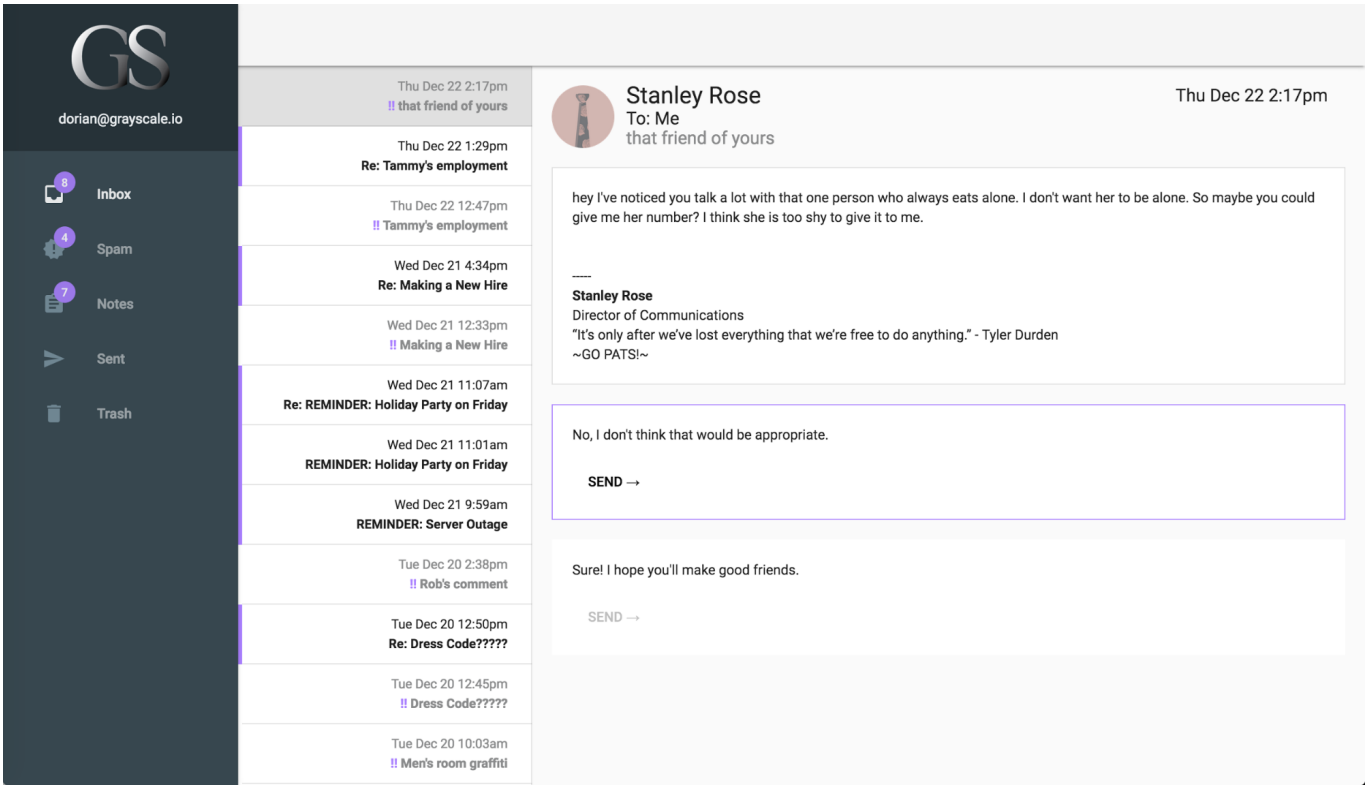

Figure 3. ***Chimeria:Grayscale*** **user interface**

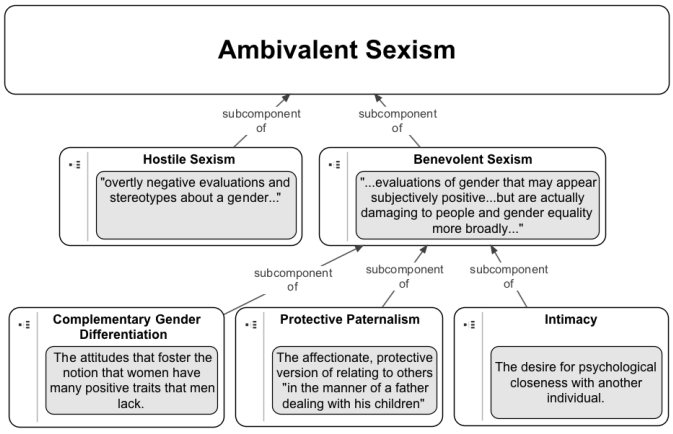

Figure 4. Overview of the ***ambivalent Sexism*** **framework.**

leverage this feature in *Chimeria:Grayscale* to allow users to explore different aspects of the *ambivalent sexism* framework with each playthrough.

Chimeria:Grayscale

Chimeria:Grayscale is a single-player interactive narrative designed to enable reflection on sexism in the workplace. More specifically, the goal of the interactive narrative is to subtly convey and enable meaningful reflection on aspects of the *ambivalent sexism* framework as related to the contemporary workplace. See Figure 4 for an overview of the *ambivalent sexism* framework [13, 14]. As the *Chimeria:Grayscale* experience is fully unsupervised, related literature would label our interactive narrative as a single-person roleplay and, thus, a guided reflective experience.

Roleplay Scenario

The roleplay scenario is as follows. Players assume the role of a Human Resources manager who has recently been hired to work for Grayscale Inc., a fictional corporation with a toxic, sexist culture. As the narrative unfolds, players must navigate tensions between ethical behavior and career advancement through their email exchanges with characters in the story.

Players are granted agency within the roleplay scenario through their ability to interact with the Grayscale email client. Figure 3 presents a screenshot of this client. Player interactions are limited to reading emails and selecting responses to emails marked with **!!** (i.e. important emails). Players can read through the contents of their inboxes at any time. They are only afforded the opportunity to respond to a single email at a time, however. As time passes within the narrative, the player's primary inbox gets populated by email messages from coworker characters. When an important email arrives in the player's inbox, the inflow of emails temporarily halts to allow players to select a response. Each important email within the narrative has an associated, unique list of responses for the player to select from. Once a selection is made, the inflow of emails resumes.

After one week has passed within the roleplay scenario, a final set of email messages arrives in the player's primary inbox. This set of messages shows the player how their choices

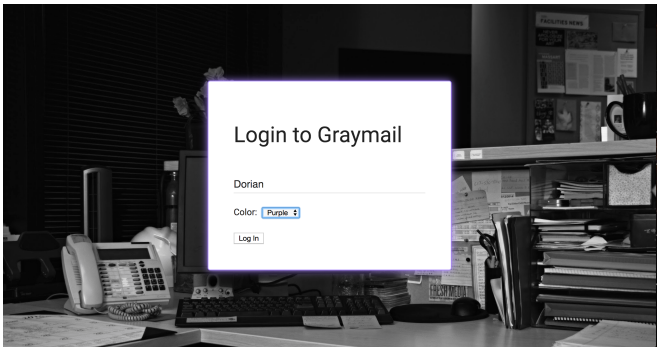

Figure 5. *Chimeria:Grayscale* login screen

affected the resolution of each subplot within the narrative. We estimate that a single playthrough of *Chimeria:Grayscale* takes 15-30 minutes.

Roleplay Induction & User Interface Design

Roleplay induction principles heavily influenced the user interface design of *Chimeria:Grayscale*. According to Yardley-Matwiejczuk [43], compared to other types of roleplays, single-person roleplays benefit most from the use of roleplay induction techniques. As *Chimeria:Grayscale* is a single-person roleplay, we expected that applying roleplay induction techniques to its design would have a significant, positive effect on reflective outcomes enabled by *Chimeria:Grayscale*.

When a roleplay is implemented as an interactive narrative, application of the *Particularization* principle is particularly straightforward. Necessary information about the setting can be communicated graphically to the player. For example, from the very moment *Chimeria:Grayscale* players start the interactive narrative, they know that the roleplay scenario is set in a corporate email client, and they know exactly what the email client looks like. In contrast, traditional roleplays would typically present such information to the player via an exhaustive written or verbal description.

We followed a few basic guidelines when applying the *Presencing* principle to the design of *Chimeria:Grayscale*. The first guideline we followed states that players can become more immersed in a role if the setting contains elements they recognize as familiar. We sought to recreate the familiar in *Chimeria:Grayscale* by designing the email client to look as generic as possible. Of course, this approach assumes that players have some prior experience with email clients. The second guideline we followed states that players can become immersed in a role more easily if their role is communicated to them in the 2nd person. The very first email message that players can read in *Chimeria:Grayscale* orients the player to their role in the setting. To enable players to immerse themselves in their role more easily, we crafted this email in the 2nd person.

In accordance with the *Personalization* principle, we allow *Chimeria:Grayscale* players to personalize their experience at the email client's login screen. Figure 5 presents a screenshot of the login screen. There, players may select the first name of the player character as well as an accent color for the interface. Though we offer few options for personalization, Yardley-Matwiejczuk [43] asserts that even a small amount of *personalization* can significantly improve the quality of a roleplay.

The Embedded Design Model

We implemented strategies from the *Embedded Design* model in *Chimeria:Grayscale* as follows. The *Intermixing* strategy was deployed when crafting the order of narrative events in *Chimeria:Grayscale*. Emails related to *ambivalent sexism* were interspersed among emails that either elaborate on the setting or set the emotional tone of the story. Due to IRB restrictions, we did not employ the *Obfuscating* strategy. The *Distancing* strategy was implemented by having players roleplay as someone other than themselves.

Semiotic Morphism: Ambivalent Sexism to Chimeria

By defining and implementing a *semiotic morphism* from the *semiotic space* of the *ambivalent sexism* framework to the *semiotic space* of *Chimeria*, we enable players to explore the *ambivalent sexism* framework through *Chimeria:Grayscale*. Let *AS* denote the above *semiotic morphism*. *Chimeria:Grayscale* implements *AS* in two parts. The first part, a computational model of *ambivalent sexism* in terms understood by *Chimeria*, captures the major ideas and structure of the *ambivalent sexism* framework. The second part, the set of important emails and associated responses that appear in *Chimeria:Grayscale*, captures nuances of the *ambivalent sexism* framework not captured by our computational model.

Our model of *ambivalent sexism* was defined in terms of *Chimeria* constructs: social categories and social category features. The model describes 4 social categories: ambivalent sexist, benevolent sexist, hostile sexist, and nonsexist; and 4 social category features: hostile sexism, complimentary gender differentiation, protective paternalism, and intimacy. Social category membership values are determined by functions of social category feature values. We derived the social category membership functions used by our model from the Ambivalent Sexism Inventory [13].

The model of *ambivalent sexism* we implemented in *Chimeria* forms the foundation for *Chimeria:Grayscale*'s narrative event and theme variability. As players select responses to important emails, fallouts are applied to the player character. Fallouts are updates to a *Chimeria* entity's social category membership. *Chimeria:Grayscale*, then, uses its model of *ambivalent sexism* to classify the player character in accordance with the *ambivalent sexism* framework. Classification involves calculating the player character's social category membership values as well as the player character's historical trajectory of social category membership values. When the player character's classification changes, the structure and content of the narrative transform to reflect this change. In this way, we enable players to explore aspects of the *ambivalent sexism* framework in tandem with their exploration of the narrative.

To better illustrate *Chimeria:Grayscale*'s narrative event and theme variability, we present several variations of one of *Chimeria:Grayscale's* final email messages. The email is sent by Grayscale Inc.'s highest-level executives and contains

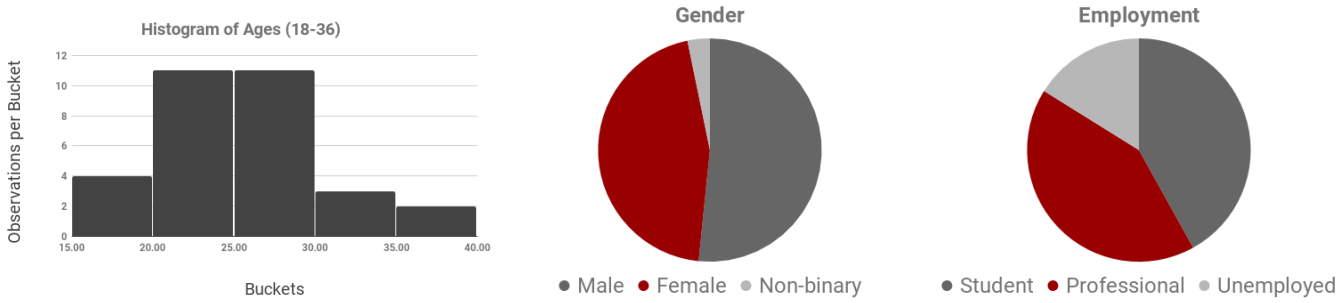

Figure 6. (Left) Histogram of participant ages; (Center) Summary of participant gender; (Right) Summary of participant employment status

their evaluation of the player character's job performance. Suppose that the player character has been categorized as a hostile sexist at the time this email arrives in their inbox. In this case, the content of the email will be as follows:

"Grayscale has concluded that morale at your branch might have been better if you had intervened more in your role as a temp manager of human resources. The current issues going on are the sort of things that lead to very bad press. Do something about this quickly or there will be consequences."

The email content presented above shows that the highest-level executives at Grayscale Inc. are more concerned with avoiding scandals than treating their employees well. Suppose that, throughout the interactive narrative, the player character's social category has frequently fluctuated between social categories. Further, suppose that the player character has been categorized as a hostile sexist at the time this email arrives in their inbox. In this case, the content of the email will be as follows:

"Grayscale is aware that some employees have expressed dissatisfaction with what has been described as the 'lax' way you have managed misbehavior in the office this past week. Don't worry about it too much — people are way too sensitive these days. That said, we would recommend providing at least the appearance of greater empathy to our employees.

Overall, we are pleased with your performance. Keep it up. You'll go places."

The email content presented above further illustrates the management philosophy of Grayscale's highest-level executives. It also shows how *Chimeria:Grayscale* uses the player character's historical trajectory of social category memberships to alter the structure and content of the narrative. There are seven additional variations of this email. In the manner illustrated above, *Chimeria:Grayscale* alters both the structure and content of the narrative throughout the experience in response to player choices.

STUDY DESIGN

To evaluate *Chimeria:Grayscale*, we conducted an exploratory, cross-sectional user study. More concretely, we sought to answer the following questions:

1. What is the player experience like in *Chimeria:Grayscale*?
2. How much, if any, *critical self-reflection* on sexism in the workplace resulted from experiencing *Chimeria:Grayscale*?

Participants

We recruited participants from reddit using the r/SampleSize subreddit. This community is dedicated to administering and participating in surveys ranging in purpose from casual to academic. Participants were not compensated in any way for their participation in our study.

Figure 6 summarizes the demographic information we collected from our study participants. 31 participants in total completed the study. Study participants were 18-36 years of age and skewed young. The gender composition of participants was 51.6% (16) male, 45.2% (14) female, and 3.2% (1) non-binary. The employment composition of participants was 42.0% (13) professionals, 42.0% (13) students, and 16.0% (5) unemployed.

Procedure

First, participants were asked to provide informed consent prior to participation in the study. Then, study participants were tasked with playing through *Chimeria:Grayscale* one or more times. Finally, after completing the previous task, participants were asked to complete a survey.

The survey consisted of an amalgam of validated survey instruments: the System Usability Scale (SUS) [7], the post-game and social presence modules of the Game Experience Questionnaire (GEQ) [36], and portions of the Learning Activities Survey (LAS) [26]. At the end of the survey, we also asked participants to provide us with basic demographic information.

The rationale behind our choice of validated survey instruments is as follows. First, the SUS was administered to measure the usability of *Chimeria:Grayscale*. We were interested in knowing if the usability of the user interface would distract from the roleplay experience. Next, the PGQ and SPGQ were administered to characterize engagement with the narrative and its characters, respectively. As engagement is critical to the success of roleplays and the GEQ was designed to evaluate game experiences, we identified these GEQ modules as well-suited for use in this study. Finally, as described previously, the LAS was administered as an indirect measure of the amount of critical self-reflection experienced by study participants.

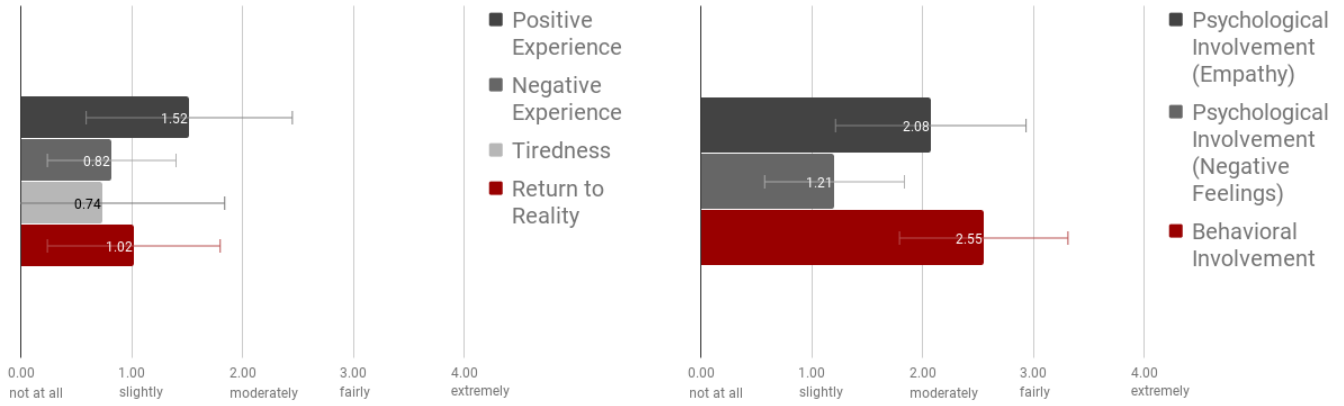

Figure 7. (left) PGQ results; (right) SPGQ results. Bars = subscale means. Error bars = subscale standard deviations.

As an aside, although we asked participants about how *Chimeria:Grayscale* affected their beliefs, we are not concerned with conceptual change in this work. We are primarily interested in the efficacy of *Chimeria:Grayscale* with respect to enabling reflection. Thus, we would consider the work a success if study participants showed strong signs of having reflected on the themes of *Chimeria:Grayscale*.

RESULTS & FINDINGS

This section summarizes the results obtained from the user study and our findings.

System Usability Scale

The System Usability Scale (SUS) produces a number between 0 and 100 that represents a composite measure of the overall usability of a system. Figure 8 presents the distribution of SUS scores obtained from our study. Participants gave *Chimeria:Grayscale* a usability score of 85.48 on average with a standard deviation of 16.19. According to Bangor et. al.'s adjective rating scale [2], these scores ranged from "good" to "best imaginable." These results suggest that *Chimeria:Grayscale*'s user interface is sufficiently usable such that it does not constitute a distraction from the overall experience. We attribute this outcome, in part, to our adherence to the roleplay induction principles of *Particularization* and *Presencing*.

Game Experience Questionnaire

Results

The Post-Game Questionnaire (PGQ) is a module of the Game Experience Questionnaire (GEQ). It measures how participants feel after they have stopped playing a game. It is composed of 4 subscales: *positive experience*, *negative experience*, *tiredness*, and *returning to reality*. The result of each subscale is a number between 0 and 4. Figure 7 presents a summary of the PGQ results. The survey results were *positive experience* (M=1.52, SD=0.93), *negative experience* (M=0.82, SD=0.58), *tiredness* (M=0.74, SD=1.10), and *returning to reality* (M=1.02, SD=0.78).

Overall, the results from the PGQ module show that participants found their experience with *Chimeria:Grayscale* to be

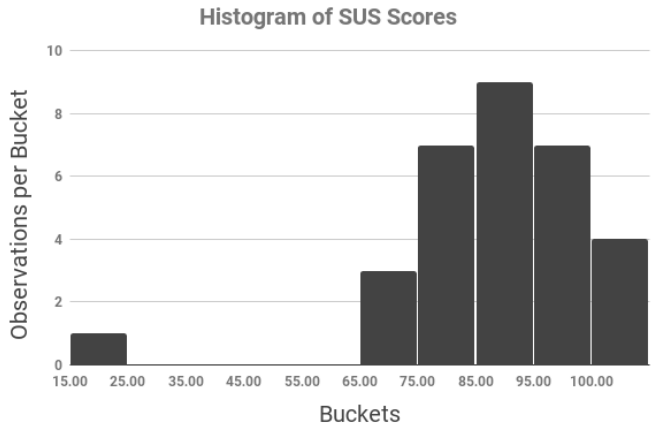

Figure 8. Histogram of SUS scores

neither particularly pleasant nor unpleasant. In addition, participants were not particularly tired after playing the game nor did they have trouble emerging from the experience. For the most part, there was no statistically significant difference in results between participants according to gender. The exception to this appeared in the results of the *return to reality* subscale (p-value: 0.047). Male participants reported significantly less trouble returning to reality (M=0.71, SD=0.47) than female participants did (M=1.29, SD=0.91).

The Social Presence in Gaming Questionnaire (SPGQ) is also a module of the GEQ. It measures participants' experience of and involvement with co-players or virtual characters. As *Chimeria:Grayscale* is a single-person roleplay, the results obtained from administering this module of the GEQ only apply to participants' experience with characters in the narrative. The module is composed of 3 subscales: *psychological involvement (empathy)*, *psychological involvement (negative feelings)*, and *behavioral involvement*. The result of each subscale is a number between 0 and 4. Figure 7 presents a summary of the SPGQ results. The survey results were *psychological involvement (empathy)* (M=2.08, SD=0.86), *psychological involvement (negative feelings)* (M=1.21, SD=0.63), and *behavioral involvement* (M=2.55, SD=0.76).

Stage		Male	Female	NB	Total
1	*This experience caused me to question the way I normally act.*	0	3	1	4 (12.9%)
1	*This experience caused me to question my ideas about social roles.*	3	5	1	9 (29.0%)
2	*While reflecting on this experience, I realized that I no longer agree with my previous beliefs or role expectations.*	0	0	1	1 (3.22%)
2	*While reflecting on this experience, I realized that I still agree with my previous beliefs or expectations.*	14	12	0	26 (83.9%)
5	*While reflecting on this experience, I thought about acting in a different way from my usual beliefs and roles.*	3	8	0	11 (35.5%)

Table 1. (Column 1) perspective transformation stage; (Column 2) LAS item; (Column 3-6) # of participants by gender identity who responded 'Yes'

Overall, the results from the SPGQ module show that participants experienced minimal negative feelings and a measure of empathy for characters in the narrative. In addition, participants felt that their actions and the actions of characters in the narrative were interdependent. This suggests that participants felt like they had agency within the narrative, a necessary quality for an effective roleplay. For the most part, there was no statistically significant difference in results between participants according to gender. The one exception was discovered in the results from the *behavioral involvement* subscale (p-value: 0.01). Male participants reported significantly less behavioral involvement with the narrative's characters (M=2.25, SD=0.76) than female participants did (M=2.90 , SD=0.46).

Findings

Our analysis of the GEQ results revealed a difference in player experience along gender lines. Male participants experienced less immersion with respect to *Chimeria:Grayscale* and less engagement with *Chimeria:Grayscale*'s characters than female participants did. We consider a few possible explanations for this observed difference in player experience. (1) The *ambivalent sexism* framework deals strictly with sexist attitudes towards women. As such, there is no instance during *Chimeria:Grayscale* where a male character directly suffers as a result of gender discrimination. Male participants may not have identified as much with the themes of the narrative as a result. It is possible that our results were, thus, skewed by our choice of model. (2) It's possible that, having been socialized in a society in which sexism toward females is intrinsic, male participants were less troubled by the sexist nature of the setting [6].

Learning Activities Survey

It is important to note that we took a conservative approach to adapting the LAS for use in our study. The original LAS was tailored for use in classroom settings and has since been adapted for numerous use cases. In this study, we opted to not administer survey items from the original LAS that fell outside the scope of our study (i.e., those specifically related to classroom settings).

Results

The Learning Activities Survey (LAS) measures whether, and to what extent, a *perspective transformation* has occurred as a result of a transformative experience. Table 1 presents a summary of the LAS results. This summary shows the proportion of study participants who reached some stage of *perspective transformation* (i.e. Stage 1: 41.9%, Stage 2: 87.1%, Stage 5: 35.5%). Recall that progression through these stages is driven by *critical self-reflection*. The table further shows that participant reflections manifested as questioning one's ideas about social roles, questioning one's normal behaviors, or contemplating new behaviors. Figure 9 presents a plot of LAS response pattern frequencies. From this plot, we observe that no study participant responded with "No" to all of the LAS survey items (i.e., response pattern: 00000). Thus, all study participants engaged in *critical self-reflection* to some extent.

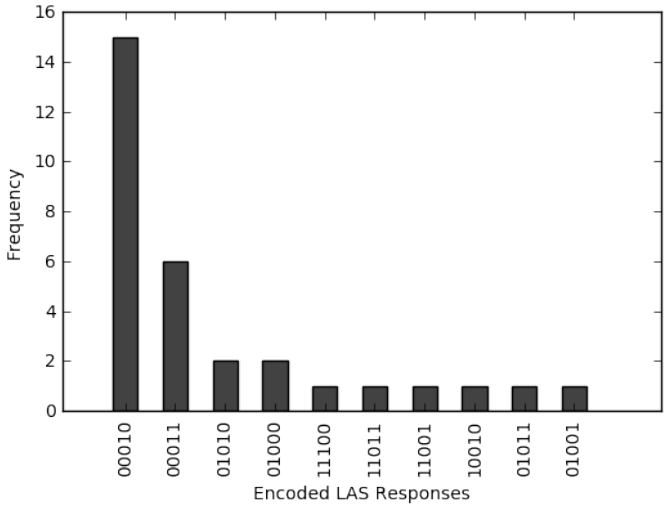

Figure 9. LAS response pattern frequencies. X-axis labels are binary representations of LAS response patterns. The leftmost bit represents answers to 1st LAS survey item i.e. "*...caused me to question the way I normally act.*". The 2nd-to-leftmost bit represents answers to 2nd LAS survey item, and so on. (0 = "No"; 1 = "Yes")

Findings

When interpreting the LAS results, there are a few important considerations one must keep in mind with respect to the process of *perspective transformation*. (1) Generally speaking, higher stages of perspective transformation are indicative of increasingly extensive *critical self-reflection*. (2) Individuals

embarking on the process of *perspective transformation* do not necessarily experience each of the stages in order.

The most and second-most common LAS response patterns observed in our study (i.e., 52% and 19% of participants, respectively) indicate that most participants, upon reflecting on their *Chimeria:Grayscale* experience, agreed with their previous beliefs without question. We consider a few possible explanations for this outcome. (1) The beliefs of these participants may have already been compatible with the *ambivalent sexism* framework. Thus, after experiencing *Chimeria:Grayscale*, there was no need for them to resolve a disorienting inner dilemma. (2) *Chimeria:Grayscale* simply did not engage these participants as well as those that did question their beliefs. Curiously, despite not having questioned their beliefs, the LAS indirectly ranked the reflections of these participants reflected quite high (e.g., *perspective transformation* Stage 2 or 5)

Participants who questioned their beliefs (i.e., response patterns 1xxxx and x1xxx) were more varied in terms of the characteristics of their reflections than their non-questioning counterparts. For example, participants in this group were observed as being in *perspective transformation* Stages 1, 2, or 5. Further, among these study participants, the ratio of participants who considered acting in a different way from their usual beliefs to those who did not was 2:3. Also, though most participants who questioned their beliefs concluded, upon reflection, that they still agreed with their previous beliefs, one study participant concluded the opposite: that they no longer agreed with their previous beliefs. Though the questioning and non-questioning groupings of study participants appear to have different characteristics at first glance (e.g., likelihood of considering new behaviors), we lack sufficient data to verify this hypothesis through statistical methods at this time.

DISCUSSION

As all study participants reported having engaged in *critical self-reflection* to some extent, we claim that *Chimeria:Grayscale* succeeded in enabling reflection. This outcome suggests that our approach to supporting reflection through interactive narratives and roleplay has promise.

Further, we believe that our approach could support reflection in a wide range of contexts: online learning platforms, personal informatics applications, games, and more. If a system has task flows involving user interaction, those task flows can be designed as interactive narratives that scaffold and enable *critical self-reflection* via roleplay, as demonstrated concretely by the design of *Chimeria:Grayscale*.

We assert that our approach is compatible with others used in prior work. For example, similarly to MAHI [28], an interactive system like *Chimeria:Grayscale* could be paired with an on-demand staff of experts to further scaffold user reflections post-experience. Another example: similarly to Saksono et. al. [38], an interactive system like *Chimeria:Grayscale* could push users to reflect at key moments using reflective prompts. Researchers seeking to leverage potential synergies could, with care, adopt a combined approach when designing interactive systems that support reflection. That being said, to properly evaluate the generalizability of our approach, further research is required.

Limitations

Our study had a few notable limitations. First, the scale of the study was rather small. Thus, the should not be considered absolutely conclusive evidence. More research is needed to verify the effects observed in this study. Second, the study was not designed to capture nuances about participant reflection. For example, our survey did not ask study participants to share details about their preexisting beliefs, their reflective process, or how *Chimeria:Grayscale* affected their beliefs. Analysis of any one of these data points would have improved the study. Finally, our results were obtained from a single source: validated survey instruments. If we had instrumented *Chimeria:Grayscale*, we could have verified our survey results with *Chimeria:Grayscale* traces.

Future Work

Our next step related to this work is to conduct a follow-up study of *Chimeria:Grayscale* that addresses all of its current limitations. Farther into the future, we intend to research how, or if, our approach should change to enable meaningful reflective outcomes for increasing numbers of concurrent users. In addition, we intend to investigate how interactive systems that operationalize our approach might fit into educational settings (e.g. massive open online courses). Finally, the differences along gender lines revealed by this study point to the challenge of designing experiences that are equally effective across users. Going forward, we will use *Chimeria:Grayscale* as a research platform for exploring strategies that address this challenge.

CONCLUSION

Systems that support reflection have helped with addressing important problems in health, education, and more. To investigate how interactive narratives and roleplaying can effectively support reflection, we conducted an exploratory, cross-sectional study evaluating an interactive narrative we created, *Chimeria:Grayscale*. Our results show that we successfully enabled our 31 user study participants to critically self-reflect on the themes of our interactive narrative. Although more research is needed to verify the effects observed in this study, our results suggest that our approach has promise. This work marks a step towards realizing our long-term vision of implementing interactive systems that play crucial roles in ecosystems of computer-supported reflective practice.

ACKNOWLEDGEMENTS

We wish to acknowledge the support of the MIT J-WEL Innovation Grant in Workplace Learning. We also thank Cecil Brown and Angela Chang for the many insights they shared with us related to this work. Finally, we wish to acknowledge contributions to the design and implementation of *Chimeria:Grayscale* from the following students as part of Professor Harrell's Advanced Identity Representation course at MIT: Chong-U Lim, Maya Wagoner, Laurel Carney, Peter Downs, Elizabeth Carre, Loren Sherman, Annie Wang, Jackie Liu, Sofia Ayala, Yao Tong, and Nadia Vivatvisha.

REFERENCES

1. Victor Asal. 2005. Playing Games with International Relations. *International Studies Perspectives* 6, 2 (2005), 359–373. DOI: http://dx.doi.org/10.1111/j.1528-3577.2005.00213.x
2. Aaron Bangor, Philip Kortum, and James Miller. 2009. Determining What Individual SUS Scores Mean: Adding an Adjective Rating Scale. *Journal of Usability Studies* 4, 3 (2009), 114–123.
3. Meg Barton, Carl Symborski, Mary Magee Quinn, Carey K. Morewedge, Karim S. Kassam, and James H. Korris. 2015. The Use of Theory in Designing a Serious Game for the Reduction of Cognitive Biases. In *DiGRA 2015*. DiGRA.
4. Eric P.S. Baumer. 2015. Reflective Informatics: Conceptual Dimensions for Designing Technologies of Reflection. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems (CHI '15)*. ACM, New York, NY, USA, 585–594. DOI: http://dx.doi.org/10.1145/2702123.2702234
5. Eric P.S. Baumer, Vera Khovanskaya, Mark Matthews, Lindsay Reynolds, Victoria Schwanda Sosik, and Geri Gay. 2014. Reviewing Reflection: On the Use of Reflection in Interactive System Design. In *Proceedings of the 2014 Conference on Designing Interactive Systems (DIS '14)*. ACM, New York, NY, USA, 93–102. DOI: http://dx.doi.org/10.1145/2598510.2598598
6. J. A. Blumenthal. 1998. The Reasonable Woman Standard: A Meta-Analytic Review of Gender Differences in Perceptions of Sexual Harassment. *Law and Human Behavior* 22, 1 (1998), 33–57. DOI: http://dx.doi.org/10.1023/A:1025724721559
7. John Brooke. 1996. *Usability Evaluation in Industry*. CRC Press, Boca Raton, FL, USA, Chapter SUS - A quick and dirty usability scale, 189–194.
8. Sunny Consolvo, David W. McDonald, and James A. Landay. 2009. Theory-driven Design Strategies for Technologies That Support Behavior Change in Everyday Life. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '09)*. ACM, New York, NY, USA, 405–414. DOI: http://dx.doi.org/10.1145/1518701.1518766
9. Raymond Corsini. 2011. *Role Playing in Psychotherapy*. Routledge, Abingdon, UK.
10. John Dewey. 1933. *How We Think: A Restatement of the Relation of Reflective Thinking to the Educative Process*. D. C. Heath, Boston, MA, USA.
11. Henry Ellington, Monica Gordon, and Joannie Fowlie. 1998. *Using Games and Simulation in the Classroom*. Kogan Page, London, UK.
12. Rowanne Fleck and Geraldine Fitzpatrick. 2010. Reflecting on Reflection: Framing a Design Landscape. In *Proceedings of the 22nd Conference of the Computer-Human Interaction Special Interest Group of Australia on Computer-Human Interaction (OZCHI '10)*. ACM, New York, NY, USA, 216–223. DOI: http://dx.doi.org/10.1145/1952222.1952269
13. Peter Glick and Susan T. Fiske. 1996. The Ambivalent Sexism Inventory: Differentiating Hostile and Benevolent Sexism. *Journal of Personality and Social Psychology* 70, 3 (1996), 491–512. DOI: http://dx.doi.org/10.1037/0022-3514.70.3.491
14. Peter Glick and Susan T. Fiske. 2011. Ambivalent Sexism Revisited. *Psychology of Women Quarterly* 35, 3 (2011), 530–535. DOI: http://dx.doi.org/10.1177/0361684311414832
15. Joseph Goguen. 1999. *An Introduction to Algebraic Semiotics, with Application to User Interface Design*. Springer Berlin Heidelberg, Berlin, Heidelberg, 242–291. DOI:http://dx.doi.org/10.1007/3-540-48834-0_15
16. Joseph Goguen. 2000. *Computation for Metaphors, Analogy, and Agents*. Springer, Chapter An Introduction to Algebraic Semiotics, with Application to User Interface Design, 242–291.
17. D. Fox Harrell. 2013. *Phantasmal Media: An Approach to Imagination, Computation, and Expression*. MIT Press, Cambridge, MA, USA.
18. D. Fox Harrell, Dominic Kao, and Chong-U Lim. 2013. Computationally Modeling Narratives of Social Group Membership with the Chimeria System. In *CMN 2013*. Dagstuhl Publishing.
19. D. Fox Harrell, Dominic Kao, Chong-U Lim, Jason Lipshin, and Ainsley Sutherland. 2014a. Authoring Conversational Narratives in Games with the Chimeria Platform. In *FDG 2014*.
20. D. Fox Harrell, Dominic Kao, Chong-U Lim, Jason Lipshin, and Ainsley Sutherland. 2014b. Stories of Stigma and Acceptance Using the Chimeria Platform. In *ELO 2014*. Electronic Literature Organization.
21. D. Fox Harrell, Chong-U Lim, Sonny Sidhu, Jia Zhang, Ayse Gursoy, and Christine Yu. 2012. Exploring Everyday Creative Responses to Social Discrimination with the Mimesis System. In *ICCC 2012*.
22. D. Fox Harrell, Pablo Ortiz, Peter Downs, Elizabeth Carre, Annie Wang, and Maya Wagoner. 2017. Chimeria:Grayscale: An Interactive Narrative for Provoking Critical Reflection on Gender Discrimination. In *ELO 2017*. Electronic Literature Organization.
23. Vicki A. Jackson and Anthony L. Back. 2011. Teaching Communication Skills Using Role-Play: An Experience-Based Guide for Educators. *Journal of Palliative Medicine* 14, 6 (2011), 775–780. DOI: http://dx.doi.org/10.1089/jpm.2010.0493
24. Geoff Kaufman and Mary Flanagan. 2015. A Psychologically "Embedded" Approach to Designing Games for Prosocial Causes. *Cyberpsychology: Journal of Pyschosocial Research on Cyberspace* 9, 3 (2015). DOI:http://dx.doi.org/10.5817/CP2015-3-5

25. Geoff Kaufman, Mary Flanagan, and Max Seidman. 2015. Creating Stealth Game Interventions for Attitude and Behavior Change: An "Embedded Design" Model. In *DiGRA 2015*. DiGRA.

26. Kathleen P. King. 2009. *The Handbook of the Evolving Research of Transformative Learning: Based on the Learning Activities Survey (10th Anniversary Edition)*. Information Age, Charlotte, NC, USA.

27. Ian Li, Anind Dey, and Jodi Forlizzi. 2010. A Stage-based Model of Personal Informatics Systems. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '10)*. ACM, New York, NY, USA, 557–566. DOI: http://dx.doi.org/10.1145/1753326.1753409

28. Lena Mamykina, Elizabeth Mynatt, Patricia Davidson, and Daniel Greenblatt. 2008. MAHI: Investigation of Social Scaffolding for Reflective Thinking in Diabetes Management. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '08)*. ACM, New York, NY, USA, 477–486. DOI: http://dx.doi.org/10.1145/1357054.1357131

29. Jack Mezirow. 1978. Perspective Transformation. *Adult Education Quarterly* 28, 2 (1978), 100–110. DOI: http://dx.doi.org/10.1177/074171367802800202

30. Jack Mezirow. 1990. *Fostering Critical Reflection in Adulthood: A Guide to Transformative and Emancipatory Learning*. Jossey-Bass, San Francisco, CA, USA.

31. Jack Mezirow and Associates. 2001. *Learning as Transformation: Critical Perspectives on a Theory in Progress*. Jossey-Bass, San Francisco, CA, USA.

32. Jack Mezirow and Victoria Marsick. 1978. *Education for Perspective Transformation: Women's Re-entry Programs in Community Colleges*. Center for Adult Education, Teachers College, Columbia University, New York, NY, USA.

33. Brendan Nyhan and Jason Reifler. 2010. When Corrections Fail: The Persistence of Political Misperceptions. *Political Behavior* 32, 2 (2010), 303–330. DOI:http://dx.doi.org/10.1007/s11109-010-9112-2

34. Eleanor O'Rourke, Kyla Haimovitz, Christy Ballweber, Carol Dweck, and Zoran Popović. 2014. Brain Points: A Growth Mindset Incentive Structure Boosts Persistence in an Educational Game. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '14)*. ACM, New York, NY, USA, 3339–3348. DOI: http://dx.doi.org/10.1145/2556288.2557157

35. Melissa Paschall and Rolf Wüstenhagen. 2012. More Than a Game: Learning About Climate Change Through Role-Play. *Journal of Management Education* 36, 4 (2012), 510–543. DOI: http://dx.doi.org/10.1177/1052562911411156

36. Karolien Poels, Yvonne A. W. de Kort, and Wijnand A. IJsselsteijn. 2013. *The Game Experience Questionnaire*. Eindhoven: Technische Universiteit Eindhoven, Eindhoven, Netherlands.

37. Danya Lee Rumore. 2015. *Role-Play Simulations: A Tool for Transformative Civic Education and Engagement Around Science-Intensive Environmental Issues*. Ph.D. Dissertation. Massachusetts Institute of Technology, Cambridge, MA.

38. Herman Saksono and Andrea G. Parker. 2017. Reflective Informatics Through Family Storytelling: Self-discovering Physical Activity Predictors. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems (CHI '17)*. ACM, New York, NY, USA, 5232–5244. DOI: http://dx.doi.org/10.1145/3025453.3025651

39. Ferdinand de Saussure. 1959. *Course in General Linguistics*. The Philosophical Library, New York, NY, USA.

40. Donald A. Schön. 1983. *The Reflective Practitioner: How Professionals Think In Action*. Basic Books, New York, NY, USA.

41. Petr Slovak, Christopher Frauenberger, and Geraldine Fitzpatrick. 2017. Reflective Practicum: A Framework of Sensitising Concepts to Design for Transformative Reflection. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '17)*. ACM, New York, NY, USA, 2696–2707. DOI: http://dx.doi.org/10.1145/3025453.3025516

42. Lawrence Susskind and Jason Corburn. 1999. Using Simulations to Teach Negotiation: Pedagogical Theory and Practice. Harvard Law School: Program on Negotiation Working Paper 99-1. (1999).

43. Krysia M. Yardley-Matwiejczuk. 1997. *Role Play: Theory and Practice*. SAGE, Thousand Oaks, CA, USA.

44. Langxuan Yin, Lazlo Ring, and Timothy Bickmore. 2012. Using an Interactive Visual Novel to Promote Patient Empowerment Through Engagement. In *Proceedings of the International Conference on the Foundations of Digital Games (FDG '12)*. ACM, New York, NY, USA, 41–48. DOI:http://dx.doi.org/10.1145/2282338.2282351