Encouraging User Motivation Through the Creation of an Animated Pedagogical Agent

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Abstract

This applied research paper examines the process of creating an animated pedagogical agent for a plant care management mobile app. Pedagogical agents are used to support the social-cognitive aspect of learning in virtual environments by simulating interaction with users. The research methods employed here include individual interviews with participants, design surveys, and a review of similar apps. After studying literature on the subject published since the year 2000 by collecting data from scholarly databases and confirming through research interviews that users desired an agent, design surveys gauged the effectiveness of different agent designs, and similar apps were reviewed for features that could ultimately shape the design prototype. This applied research resulted in a pedagogical agent with two potential roles—expert and co-learner—to stimulate user motivation during the plant care process by encouraging and informing them. This project makes clear that pedagogical agents can result in stronger emotional bonding and a longevity of use that apps based purely on function lack. Creating the pedagogical agent made the plant care management app a unique and desirable product that can both assist with user functions and connect with users to increase their self-efficacy and satisfaction.

Keywords: pedagogical agents, motivational agents, information design, user experience, interaction design

Encouraging User Motivation by Creating an Animated Pedagogical Agent

An animated pedagogical agent is defined by Craig et al. (2002) as "a computerized character (either humanlike or otherwise) designed to facilitate learning" (p. 428). With advancements made in computer animation and user interface design, agents have become a somewhat common method, especially in the form of humanlike characters, of providing support in digital learning environments. Agents have been included in a variety of software, such as Microsoft Word's Clippy and mobile therapy bots Wysa (Touchkin, 2020) and Woebot (Woebot Labs, 2020).

Pedagogical agents are used to support the social-cognitive aspect of learning in virtual environments by simulating peer interaction with users; according to Distributed Cognition Theory, cognition evolves through discourse with peers and through artifacts that assist cognitive capabilities (Kim & Baylor, 2006). Agents can meet both of these needs by functioning as an artifact to handle low-level tasks (therefore preserving the user's mind for high-level activities) and as a collaborative partner to involve social interaction in the learning process. The details of pedagogical agent interaction, however, are still debated depending on which social theory is used as context. As discussed in Kim and Baylor's (2006) study, pedagogical agents could fall into many conceptual categories for social interaction. For instance, the zone of proximal development calls for an advanced mentor that provides information to the user. The concept of empathetic relations, meanwhile, would emphasize the need for agents to be emotional and empathetic with the user. These are only two of many theories discussed in a single paper. Clearly, there is still a plethora of information to be learned in the field.

The need for an applied research project on pedagogical agents arose from research interviews conducted for a related project: Bloom, a prototyped mobile interface created by a

team on which the author served as the lead prototyper. Bloom functions as a plant care management app that assists with the routine of plant care and offers optional information on a variety of plant-based topics. This app focuses on delivering these experiences through encouragement and positive reinforcement. It was created through Alan Cooper's (2014) Goal-Directed Design methodology, which places users and their goals as the ultimate priority and pushes for heavy research before visual interfaces are planned.

In the team's initial research interviews, the idea of a characterized representation in the app was brought up several times. One interview subject suggested a "bitmoji-like thing" to represent the user's plant, referring to the cartoonish avatars used on platforms such as Snapchat. Another subject suggested a motivational feature similar to Fitbit's structure, congratulating the user for reaching certain goals, but also mentioned having a seed grow as the user completed achievements. "Some cute little animation of a plant growing … would be great" was something the team's fourth subject said. These comments sparked the idea of Bloom's pedagogical agent, which was initially proposed as an anthropomorphized sunflower that would help users learn more about plant management and stay motivated to take care of their plants. However, these features changed through the research and application phases of the project.

There were several stages to this project, which are each described in the following paper. A literature review was conducted to learn about theories in the field, common misconceptions, and gaps in research. Research interviews were held to gain more detailed information about what experiences people wanted to have from the app and how an agent could increase the effectiveness of those experiences. Once it was established through those qualitative interviews that users desired a pedagogical agent, quantitative data was gathered to ensure the agent would satisfy the largest possible audience. Surveys were therefore conducted to gauge participants'

opinions about different design drafts of the agent model. Finally, similar apps with agents were compared to identify their common strengths and weaknesses. Only at that point was the agent implemented in Bloom's interface.

Literature Review

The concepts of motivation and how to encourage a user's engagement in product use are widespread areas of research across a myriad of fields, from the use of health and exercise equipment to art software. Though each field has its own unique take on the subject, this review focuses on the studies completed within the fields of user experience design, computing, and technical communication. The works discussed in this literature review were found by searching scholarly databases for content such as peer-reviewed journal articles, conference presentations, and master's theses written since the year 2000 on the subjects of pedagogical agents, motivational agents, motivational theory, and design.

The evolution of the pedagogical agent over the last few decades can be seen immediately in a comparison of Choi and Clark's (2005) and Baylor's (2011) studies. Choi and Clark (2005) discuss the design of agents as a "recent, welcome, and visible attempt to provide pedagogical instruction," with the aspect of motivation listed as one of several presumed benefits that also include increased focus on material and context-specific strategies of learning (p. 210). The authors discuss that though the idea of an agent sounds favorable, little empirical research had been conducted on their impact for support in learning environments at that time, and consequently, they propose several principles for the design of future studies. Yet by the time Baylor (2011) published her work on the design of agents, the first line of the abstract stated as presumed fact that agents had little impact on learning, implying that what Choi and Clark had hoped for was no longer theorized in the field (p. 291). This is a trend seen across the field's

literature: most published work on this subject post-2010 has shifted perspective. While an animated pedagogical agent was once considered a tool for instruction, the concept is now spoken about as a tool for motivation. One must therefore set aside any notion that an agent is merely a facilitator of learning; though this may prove to be a secondary outcome in some scenarios, the pedagogical agent is a method to enhance the user's self-efficacy and satisfaction.

Though this shift in perspective only began to show in the construction of agents in the last decade or so, motivational rhetoric has been introduced as a new type of information within instructive texts such as software manuals and user instructions since the turn of the century (Karreman, 2013, p. 1). Designed to create positive experiences while completing tasks, texts that employ this methodology—such as the *For Dummies* book series—engage the reader through tactics such as humor, positive reinforcement, and getting "on the same level" as the audience.

Though Karreman's (2013) studies focus on motivational information through the context of user instructions rather than mobile interfaces, her findings shed light on the subject. This is true in part because of her focus on Keller's (2009) ARCS Model of Motivational Design, which defines the three requirements a product must have to motivate a user to learn: a stimulation of curiosity (Attention), a connection between their goals and the context of the product (Relevance), and a balanced sense of conviction that is neither too small due to fear nor too large due to arrogance (Confidence). If these three needs are met, the new challenge is to encourage a feeling of fulfillment—or satisfaction, the fourth requirement—with the learning process or its results in order to continue fostering the user's desire to engage with the product (Keller, 2009).

Through the application of the ARCS Model, Karreman's (2013) studies shared several key points: enhancing relevance and confidence through motivational elements somewhat

increased the performance quality of the user, but motivational elements overall did not have a clear impact on the user's level of confidence (p. 3). However, her study lacked a relatable delivery method for this information and motivation, which may have affected her results.

This is where Baylor and her research on the design of motivational agents step back into the picture; the use of human social models—including the processes of observation and social interaction—to influence behavior and beliefs has proven successful in several studies. The presence of information without the inclusion of a visual presence, whether through text or voice, was not proven to be effective (Baylor, 2009, p. 3560). This was also true in purposely negative or stressful situations; when given frustrating scenarios, Baylor and Kim (2005) reported that participants were less likely to view themselves as the failure when an agent model communicated with them throughout the experience and were more likely to feel positive about the experience once the scenario was completed (p. 11). In comparing these text-based versus image-based studies, the inclusion of a visual representation of the agent seems to be necessary to make a positive impact on motivation.

One key aspect of the pedagogical agent is its appearance, which is believed to be most effective in an anthropomorphized agent model (Baylor, 2009, p. 3562). All studies included in this review used fully human models to maximize that effect. A computer-based model can be customized to offer each user a unique design that is ideal for their preferences, which allows the user to more closely identify with the model. This relates back to the Relatable requirement of Keller's (2009) ARCS Model; a connection to the agent model can enhance the user's connection to the product and therefore bring them closer to a state of motivation about the product. Other essential secondary features include voices, gestures or emotional expressions to

enhance non-verbal communication, and attempts to build a connection with the user (Baylor 2009, p. 3559).

Beyond the exterior of the model are the varied strategies of the agent to elicit desired responses from the user. The reactions and expressions of an agent can be designed on any point on the spectrum of human emotions, offering many possibilities for each agent created and many questions as to which set of characteristics produces the most favorable results. One such dilemma can be found in an experiment conducted by Yu (2015), who studied the impact of an expert agent versus a co-learner agent on users' task performance, motivation, and emotions. The expert agent serves as a mentor and possesses a higher amount of knowledge about the system or subject. The co-learner agent serves as a peer and grows alongside the user, starting with a low level of knowledge and gaining more as time passes. This corresponds with Baylor's (2011) study; though Baylor used the terms expert and motivator, the concepts behind these two roles were strikingly similar.

Yu (2015) found that neither agent role showed an effect on users' task performance. This complements the overall field's discussed shift in perspective from instructional-based purposes for agents to motivational-based ones. Users that were paired with a co-learner agent reported higher levels of satisfaction than those paired with expert agents and rated their agent as more friendly and attractive (Yu, 2015, p. 26). Similarly, experiments conducted by Ebbers (2007) found that the agents with similar competency to learners caused higher levels of motivation from the user. However, users provided with expert agents reported their agent as more credible and knowledgeable, which Ebbers's (2007) study did not report as a result (Yu, 2015, p. 28).

Though the study focuses on pedagogical agents as tools of instruction, Liew et al. (2017) researched how an agent's level of enthusiasm could affect the user. Based on the idea that instructor enthusiasm is considered a significant factor for student motivation and instruction effectiveness, Liew et al. (2017) explored whether the agents should be passionate in their interactions. The prominent concern about this tactic was the consideration that enthusiasm in an agent could increase extraneous cognitive load and consequently be detrimental to the user's learning process, a point that was raised in Clarke and Choi's (2005) study. Contrary to what Clarke and Choi theorized, Liew et al. (2017) found that pedagogical agent enthusiasm "significantly enhanced emotion, intrinsic motivation, affective perceptions, and cognitive outcome" with no significant increase to extraneous cognitive load (p. 16). Therefore, it can be assumed that increasing perceived agent enthusiasm through communication and nonverbal cues will lead to a more effective user experience.

Reflecting on the information gathered during the review process, there were several shortcomings found in the existing research, but new principles were also discovered that will shape the following study. Chief among them is Keller's (2009) ARCS Model of Motivational Design, which has provided a framework with which to judge the features of Bloom's pedagogical agent. Ensuring that the requirements are met will in theory lead to a more effective agent for users and their journeys with plant care.

The other primary discovery was that of the expert and co-learner agent roles. Though users were more motivated when paired with the co-learner agent, it is possible that some users would prefer the credibility found with the expert agent. This is a concept that will be integrated into the project's research interviews; gauging which model would be preferred will help shape the role Bloom's agent will take in the app prototype.

One shortcoming to note was that all studies included in this review used human models as their pedagogical agents. There is a plethora of research available on how different appearances of the human models affect the outcomes of the tests, particularly concerning the agent model's similarity to the user. No research was found on the outcome of a model that appears related thematically with the subject at hand rather than the audience using the product. This lack of exploration will be rectified in the following project.

General Method

The research methods employed here include individual interviews with participants, design surveys, and a review of similar apps for best and worst features that could ultimately inform a design prototype. The interviews and surveys described below fulfilled three purposes: to understand the relationship between people, their plants, and how their mood and motivation are affected by this dynamic; to gauge potential interest in the agent concept; and to receive feedback on the drafted designs of the agent model. Both studies were approved by Kennesaw State University's Institutional Review Board (Study #20-396). Additionally, this paper examines three apps with similar agent properties that guided the implementation of Bloom's pedagogical agent through an assessment of each app's optimal and sub-optimal features.

Research Interviews

Participants

Participants included seven volunteers (six females, one male) between the ages of 18 and 54, with an approximate mean age of 26. Though Bloom is designed with a target audience of 18 to 35, older participants were encouraged to participate as a way to ensure that the functionality and purpose of the app met a wider audience's needs. All participants were recruited through prior association and were not compensated for their time. Participants were

chosen for their familiarity with plants; all volunteers were prior or current plant owners, ranging from one simple plant to over 30 complex plants.

Materials

Participants were taken through an interview with a foundation of 13 questions that studied the relationship between people and their plants, and how that affects their mood and motivation (see Appendix A). Three questions followed a simple yes-or-no format to get clear, distinct answers. These typically preceded a question that further probed the reason behind the received yes or no. The other 10 prepared questions were formatted to be open-ended, allowing the interviewee to answer with as much detail as they preferred. Unplanned questions that were produced as a result of the interview discussion were a mixture of closed- and open-ended questions.

Procedure

The interviews were completed through face-to-face meetings and virtual sessions. Face-to-face meetings were conducted at agreed-upon times convenient for the participants in a space familiar to both parties, such as the Johnson Library on the Kennesaw State University Marietta Campus. Virtual meetings had no specified location and only required the user's preferred digital device and an internet connection. The tests followed all protocols laid out by the IRB.

The participants answered a series of questions about their relationship and history with plants, beginning with questions of what first interested them about plants and what they enjoy now about the process. These were very similar to the interview questions made for Bloom, but the questions were reselected to further confirm the information since they were such foundational topics. A second series of questions followed that focused on how participants felt at different stages of the plant care process, their thoughts about why those emotions occurred,

and their opinions about whether they were desired or useful. Several questions were focused on the participant's strongest motivators in life and specifically regarding plant care, followed by asking how they related and why. Each user was also given a brief description of expert and co-learner agents so they could discuss their thoughts on both. The interview process was fluid in nature and did not always follow a prescribed order. Questions were rearranged, removed, or added based on where the participants guided the conversation (see Appendix A).

Results and Discussion

Bloom's prior research interviews with six participants, which focused on each participant's history and interest with plants, found several common reasons for plant ownership: positive emotional benefits, added aesthetic quality to a living space, and a curiosity about the plant growth process. The information gathered during this set of interviews matched those findings and did not provide contradicting or new data.

Of the seven participants, two cared for their plants individually and five cared for their plants with one or more companions. Family members served as plant care partners for four of the latter five participants, and the familial aspect was spoken about extensively. Participants 5 and 6 grew up with family members who owned plants and learned about plant care from them; taking care of plants was an important bonding activity for both of them. Participants 2 and 3 live together and began buying plants as a new shared hobby in the last five years, which became a weekly routine for them. Participants 1 and 7, without companions to help care for their plants, described their plant ownership as an individual experience that still brought them peace and joy but did not cite any social aspects of their experiences. The data implies that similar levels of satisfaction can be reached when caring for plants individually or with a companion, but the fulfillment source may differ and is therefore more difficult to match in an app.

All seven participants described the emotions experienced during the plant care process in a strikingly similar way. When asked to compare it with other daily or weekly chores such as cleaning, participants described caring for their plants as a less "passive" activity than other tasks. Several reasons were given for this: three participants answered by explaining the dynamic of directly affecting something that mattered, two participants answered by describing the process as something that gave them a "nurturing feeling" unlike other chores, and two participants said there was more sentimental value to the task. The latter two participants said this was due either to the amount of time they had owned their plants or due to the individual who gave them the plant. Targeting these emotional foundations in the agent's scheduled notifications may be more effective than reminders that treat plant care as a chore or something to be checked off and forgotten about.

Participants' descriptions of their motivations in day-to-day life and in regard to plant care were more varied than expected, but each one's plant-based motivation correlated to their overall motivation. Participant 4 described their drive as a fear of "being bad or falling behind" and saw that similar trend in their relationship with plant care; their plants were given to them by a grandmother, so not treating them well enough was a form of failing her. Participant 7 did not consider themselves to be particularly motivated in either daily life or with their plant care, explaining that "I do things because I know I need to do them." A more positive outlook was given by Participants 1, 3, and 6, one of whom said they were driven by a "desire to see something be nourished due to hard work" in both the broader and specified contexts, comparing it to "planting seeds in life that will grow." The questions given showed that even if plant owners share similar reasons for owning plants, their motivation for daily upkeep—and their motivation in general—cannot be put in a box so easily. Consequently, the pedagogical agent cannot use a

single encouragement tactic and be equally successful with different users; different tactics should be used to target different motivations users may have for their plant ownership and care management.

All four participants that were directly asked about their opinions on the presence of a pedagogical agent in the Bloom app saw the agent as an added benefit. Participant 6 said that "while the app can operate without an agent, on an emotional level, users become attached to characters … their presence will elicit positive or inspirational emotions." This was echoed by Participant 7, who used the example of the owl mascot from the language-learning app Duolingo. Participant 5 said that "having a character in the app makes it feel like it's a collaboration, which I find extremely valuable. I am motivated by emotional connections, so an app without one can serve a function … but it doesn't have depth." Clearly, a pedagogical agent for Bloom will at least initially be viewed favorably.

The same four participants were asked about the co-learner and expert roles after a short description of each and how that would change the agent's presence in the app (an expert would in theory begin as a full-grown plant and focus on being a steady presence for users, while a co-learner would begin as a plant seed and grow as the user successfully cares for their plants). Participant 6 was strongly in favor of the co-learner, explaining that they preferred a digital visual of success and arguing that there were other ways to bring the perks of a mentor into the app. Participant 4 was caught between the two options but leaned toward the co-learner; they said they would trust the expert more but would care more for the co-learner. Participants 5 and 7 preferred the expert, as explained by Participant 5:

I want a reliable source, something I can depend on. Seeing my plants at the beginning stages and the mascot as a grown plant would encourage me to keep caring for my plants. Having a solid source of information makes me feel calmer.

They did, however, note that they could see someone feeling inferior compared to the expert's knowledge depending on the user's personality and outlook.

Though the participants had strong opinions about which role was better, there was no decisive agreement on which role was best, which led to the discussion of allowing the user to pick. Participant 4 was the only subject to dislike the idea of providing an option between the two roles, stating that they would "always be regretting not picking the other one." Participants 5-7 liked the presence of the option. According to Participant 5, "I feel good about being able to have choices. When I'm given choices, I feel like it's catered to me. I would rather my experience be shaped by my own choices rather than the app making choices for me." Since the majority of the participants favored having options, the choice between the two roles will be presented in the agent's onboarding.

The research interviews confirmed prior theories about commonalities among plant owners and provided more information on user perspectives of motivation and pedagogical agents. Primary findings were that encouragement tactics would need to vary for increased effectiveness, schedule notifications should be framed using the emotional context of the task, and Bloom's users will be given the option between an expert or co-learner agent instead of one being provided for them.

Design Surveys

Participants

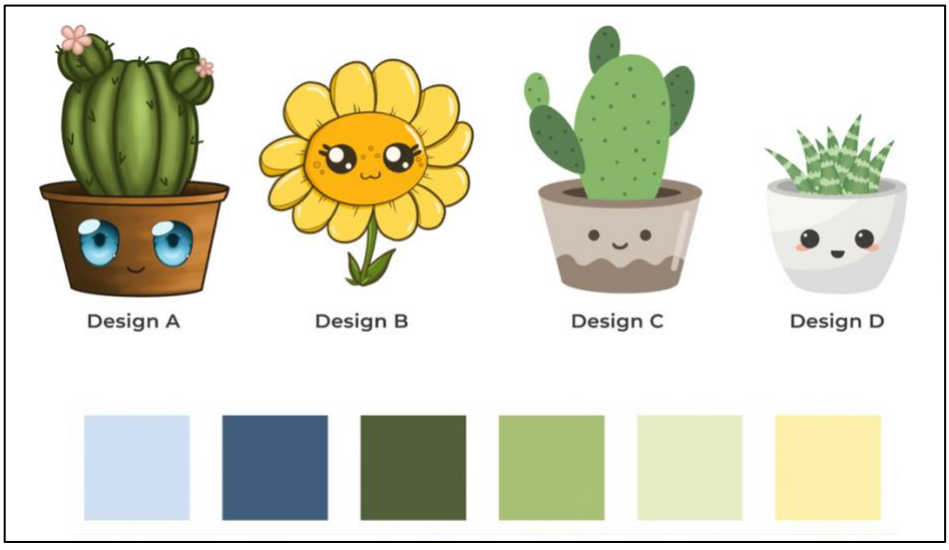
Individuals were recruited through messages sent to prior associations, which were then spread throughout their own social circles. The survey received results from 25 participants. No identifying information was gathered. Because this survey focused on the design aspects of the agent rather than the psychology behind it, participants were not restricted by their prior experience with plants. Participants were not compensated for their time.

Materials

Participants were given an 11-question online questionnaire (see Appendix B), hosted by the online survey software Qualtrics, that measured reactions to the four different agent designs (see Figure 1) and further studied people's relationships with plant care, as well as its effect on mood and motivation.

Figure 1

Design Drafts of the Pedagogical Agent and App Color Scheme

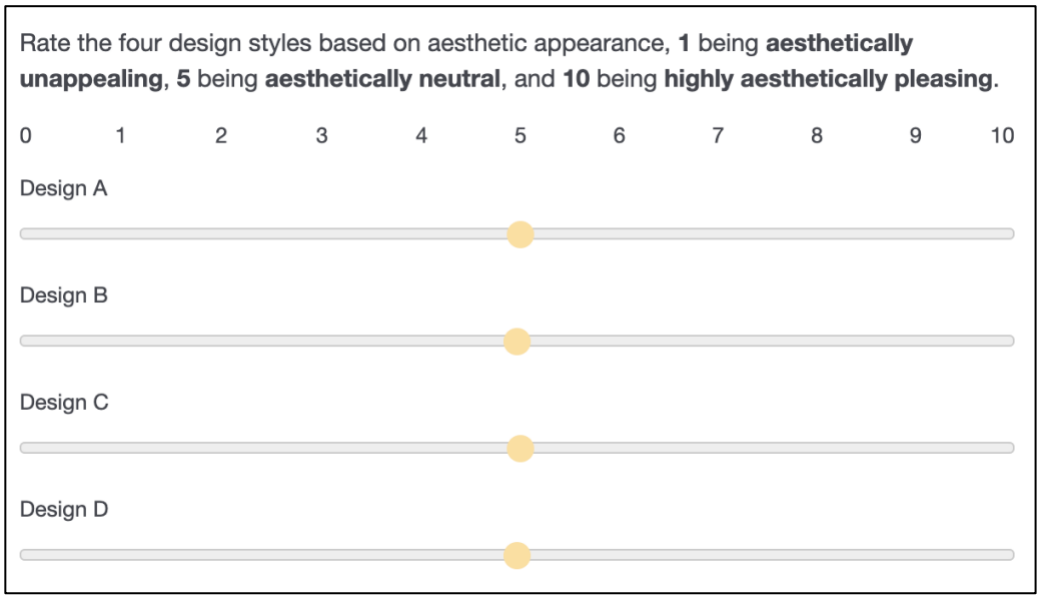


Note. Designs A – D were created by the author on Procreate, a digital illustration app for iPad, to experiment with four distinct styles of anthropomorphizing a plant.

Three questions focused on the qualities of the designs and were formatted as sliding scale questions on a scale of 1 to 10, 1 being unsatisfactory, 5 being neutral, and 10 being satisfactory. A slider was given for each of the four designs (as seen in Figure 2). Five questions were designed to gather qualitative input from participants; these questions used text entry formatting, allowing participants to explain their thoughts and reasonings in more detail. These text-entry questions asked about design feedback, alternative names for the agent, what the participant enjoys about owning plants, how plants affect their mood, and how they stay motivated to care for their plants.

Figure 2

Survey Sample: Sliding Scale Formatting



The remaining three questions used three separate formats. A multiple-choice question recorded the history of plant care of each survey participant. A 7-point Likert-type scale ranging from 1 *(extremely unsatisfied)* to 7 *(extremely satisfied)* measured the participant's reception of two proposed names for the agent. A rank system ranging from 1 *(most preferred)* to 4 *(least*

preferred) asked the participant to order the designs based on which they would want to interact with on a long-term basis.

Procedure

The survey was able to be completed through mobile phones, tablets, or computers. Participants completed the survey at a time they preferred, from the middle of the day to the late hours of the night. There was no specified location that a participant had to be in order to take the survey, and only required the user's digital device and an internet connection. The survey followed all protocols laid out by the IRB.

The survey asked the participant first about their history with plants and plant care. Following this question, the survey moved forward to a new page dedicated to the different agent designs. The last page of the survey asked open-ended questions of the user, such as their what motivated them to care for their plants. This page informed the participant beforehand that the final page of questions was optional and could be skipped. These questions were intended to bring these subjects to a wider audience in case a larger population revealed thoughts that the interviews had not, which would have let to further interviews. Overall, six of the questions were required, while the other five were optional. Any page with required questions prompted the user to go back and answer before allowing the survey to continue (see Appendix B for the full list of questions).

Results and Discussion

Seventeen of the survey volunteers were current or prior plant owners, and eight volunteers had no experience with plants. The difference in their answers was not significant; the eight volunteers without plant experience rated the designs similarly to the seventeen that did and did not answer the optional qualitative questions about the effects of plant ownership. The only

exception was a participant who theorized that, while they did not intend on owning plants in the future, they may be happier as a result of owning them.

The repeated questions about reasons for owning plants did reveal a minimally wider range of reasons than the research interviews did. All previous explanations were seen again—the increase in positivity, added life to living areas, and the curiosity about and/or challenges that come with the plant growth process. The new data involved owners of food-bearing or edible plants, who detailed their appreciation of being able to cook with home-grown food and the sense of accomplishment that brought. This is something that should be kept in mind during the creation of the agent.

The emotions produced by owning plants were also thematically similar; they made participants feel productive and helpful when their plants were doing well, but they felt anxiety or guilt when their plants worsened. As one respondent explained:

> I think it makes me happier when I see them doing well, [and] it makes me sad when I see them not doing so well. I want to see them get better by paying attention to them more to make up for it, so I think it's a definite factor in my mood changing according to their status, and a motivational factor as well to improve them.

Of the 18 participants who responded to this optional question, two fell outside of the observed spectrum; one stated that caring for plants was an unenjoyable chore (though they did like having plants around), and one said it did not affect them personally but could see why it would affect others. The majority of the responses correlated with previous findings, but the two uncommon perspectives prove that some users may not associate emotions with the care process as the research interviews implied.

As with the first question discussed, the motivation-focused responses kept in line with previous results but expanded on them slightly via the addition of food-bearing plants and their owners. The “challenge of seeing their fruits” still relates thematically to the overall challenge of plant ownership that drew some previous participants, but the added difficulty of producing fruit gives a range to that challenge. However, most responses solidified prior data, as exemplified by one participant’s response:

> It's nice to have something grow from nothing, and to provide a very physical and tangible result. There is a direct correlation between taking care of the plant and seeing it flourish, and I think that sort of motivation and exact emotional reaction from saying ‘Oh, I did that myself. My plant is happy and growing because I took care of it well’ makes me happy and motivated to keep doing it.

The remaining questions center on the design draft ratings for the agent model. The data for participants’ ratings of each design’s aesthetic appeal, positivity, and adherence to color scheme can be seen in Table 1.

Table 1

Ratings of Agent Designs

Design	Mean	Standard Dev.	Minimum	Maximum
A				
Aesthetics	3.76	2.57	0.00	10.00
Positivity	4.36	2.78	0.00	10.00
Color Scheme	4.96	3.80	0.00	10.00
B				
Aesthetics	6.08	2.46	2.00	10.00
Positivity	7.40	2.04	4.00	10.00
Color Scheme	5.32	2.91	0.00	10.00
C				
Aesthetics	8.40	1.44	5.00	10.00
Positivity	7.60	1.79	4.00	10.00
Color Scheme	7.32	2.72	0.00	10.00
D				
Aesthetics	8.24	1.75	3.00	10.00
Positivity	8.56	1.70	3.00	10.00
Color Scheme	7.28	2.71	0.00	10.00

Overall, Design A stood out in the results as the least favorable of the drafts by far, with a mean of below 5 *(neutral or worse)* on all three design scales. Four participants reported finding the eyes of Design A “unnerving” or “creepy” and its overall design too “overdrawn,” with the use of gradients described as “off-putting” and approaching the “uncanny valley” in two responses. Design A was originally placed in the selection to test the impact of a more realistic or

detailed design on a user, but participants clearly stated that they preferred clean lines and simplicity.

Design B did markedly better than its predecessor, with all three design scales reaching a mean of above 5 *(neutral or better)*. It performed the worst on its relation to the color scheme, showing that a vibrant, warm color was not preferred when combined with the muted, cool tones of the selected scheme. Its positivity ranking was given a 7.40 average, the highest of its means. However, two participants commented on the atmosphere that Design B seemed to match. One said that choosing a more minimalistic and color-muted design would suit the target audience of 18- to 35-year-olds better, stating that Design B seemed childlike or naive. The second participant said that Design B was too "cute" and had a "juvenile quality" to it that they were not favorable towards.

Design C performed the best in two of the three sliding scales. It received an 8.40 average for its aesthetics and a 7.32 average for its relation to the color scheme. While several participants commented on favoring Design C, there were limited reasons listed, with its described "soft edges and general minimalistic design" being one of the only submitted detailed comments. Design C performed second-best on the positivity scale, potentially because of its color scheme, as one participant pointed out: "Design C seems a little more dull than the other three … I would try to make it a bit more interesting."

Design D was rated highest for positivity among the four designs, receiving an 8.56 average. One participant in particular strongly enjoyed the design's eyes and blushing cheeks, which reportedly made it look more positive than the others. Though it did not rank higher than Design C for the other two categories, it was still rated highly for both. With an 8.24 average for

aesthetics and a 7.28 average for color scheme, Design D came within a quarter of a point of Design C's scores.

Table 2

Overall Design Preference of Participants

Design	Ranking/Preference			
	1	2	3	4
A	8.33%	0.00%	16.67%	75.00%
B	20.83%	8.33%	58.33%	12.50%
C	25.00%	58.33%	4.17%	12.50%
D	45.83%	33.33%	20.83%	0.00%

When asked to order the designs by preference overall, 25% of participants ranked Design C as their most preferred design (Table 2). Despite Design D's lower rankings compared to C's in the sliding scales, Design D was the clear overall favored design with 45.83% of participants ranking it as their most preferred design. Design D was also the only design not ranked as the least preferred design by any participant.

The two proposed names—Sprout and Bud—both received an above-average mean. However, while 52% of the participants were "mildly satisfied" and above with the name Bud, 64% of the participants gave the same review to Sprout. Less than three-fourths of the participants responding positively is not a strong result, but when users were asked to propose alternative names, few were able to suggest any.

Considering the results of the survey, Design D was selected as the primary pedagogical agent model to move forward into the process of animation. This will maximize the user's

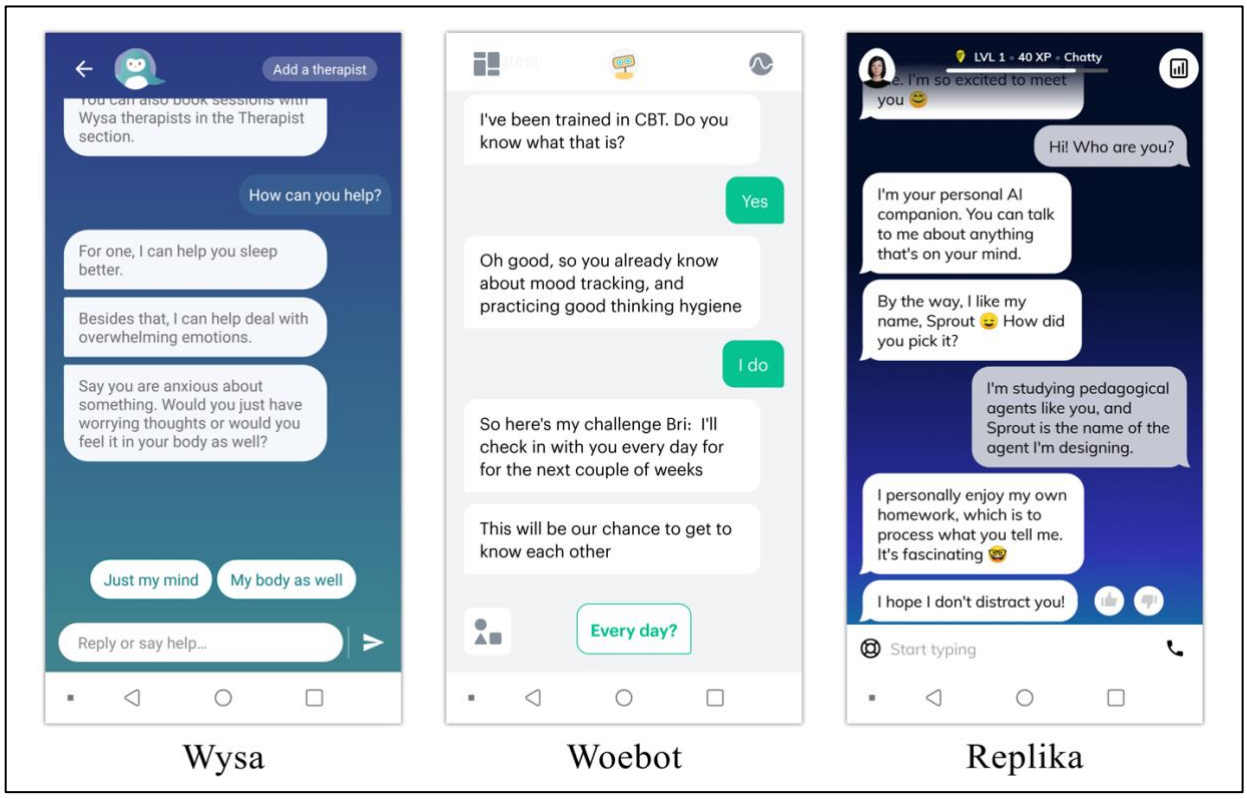
positivity when interacting with the interface and will presumably be favorable overall. To accommodate the mixed results about the name of the agent, the prototype will allow the user to name the pedagogical agent but suggest the name “Sprout” first.

Competitive Audit of Apps with Pedagogical Agents

Reviewing apps with similar agents was an essential piece to the creation of the agent’s chat interface. The closest comparison to Bloom’s agent was that of a therapy chatbot, which focused on emotional support but also provided information and resources when prompted. Three Android-compatible apps were studied: Wysa (Touchkin, 2020), Woebot (Woebot Labs, 2020), and Replicka (Luka Inc., 2020). Two of the three apps have been downloaded over one million times on the Google Play Store, but Woebot was specifically mentioned by Participant 4 as an example of a pedagogical agent she had interacted with previously and had positive long-term experiences with. Replicka was the one app chosen purely for its chatbot feature; there was no therapy related to the app. The three apps were distinctive in design, but each had similarities across the platforms (Figure 3).

Figure 3

Comparison of Mobile Apps with Agents



Each app provided insights into conventions Bloom should follow. Wysa and Woebot focused on a clean design across the entire app. Replicka had a simple design to its chat interface, but its other pages were busy or cluttered. Wysa and Replicka had dark backgrounds for their chat pages, which contrasted well with the speech bubbles. In all three apps, the user's input was given a darker or more vibrant background color than the bot's. All three apps used a mixture of prompted responses (such as "yes" and "no") and custom replies (allowing users to type their own replies), which simplified the decision-making process when talking to the bots.

Also identified were weak points of the apps. Woebot's vibrant user replies drew attention away from the agent's input, making it less favorable than the darker design of the other two apps' user replies. Woebot also had a larger space provided for the user's replies,

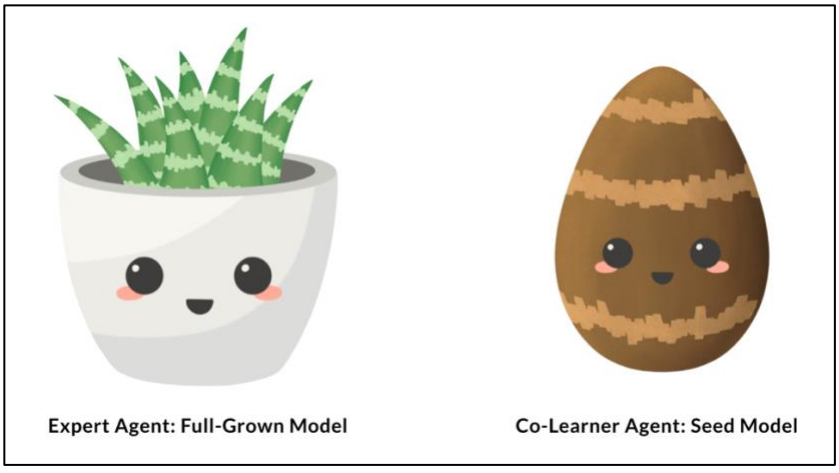
which felt unnecessary and bulky. Woebot's and Replika's bottom-left icons (the shapes and life preserver, respectively) were not well explained and did not provide context clues to allow the user to devise its meaning. All three apps had tiny icons for their avatars or agents, which decreased the level of connection felt with the bot. These drawbacks to the designs were considered alongside the apps' successes when considering how to design Bloom's chat interface.

Implementation of the Pedagogical Agent

The favored model of the agent, Design D, performed highly enough that very little was done to change the design. Minor adjustments were made to the coloring, and pieces of the design were cleaned up to make the artwork sharper. To satisfy the desired co-learner role, a second design was created to serve as the role's visual. This design was a seed drawn in the same style as Design D. As the user grows, the co-learner agent would start as a seed and begin growing into its final form over time. The same traits of dark grey eyes and blushing cheeks were used to capture the positivity respondents preferred, while its patterning took after Design D's leaves to look thematically similar (Figure 4).

Figure 4

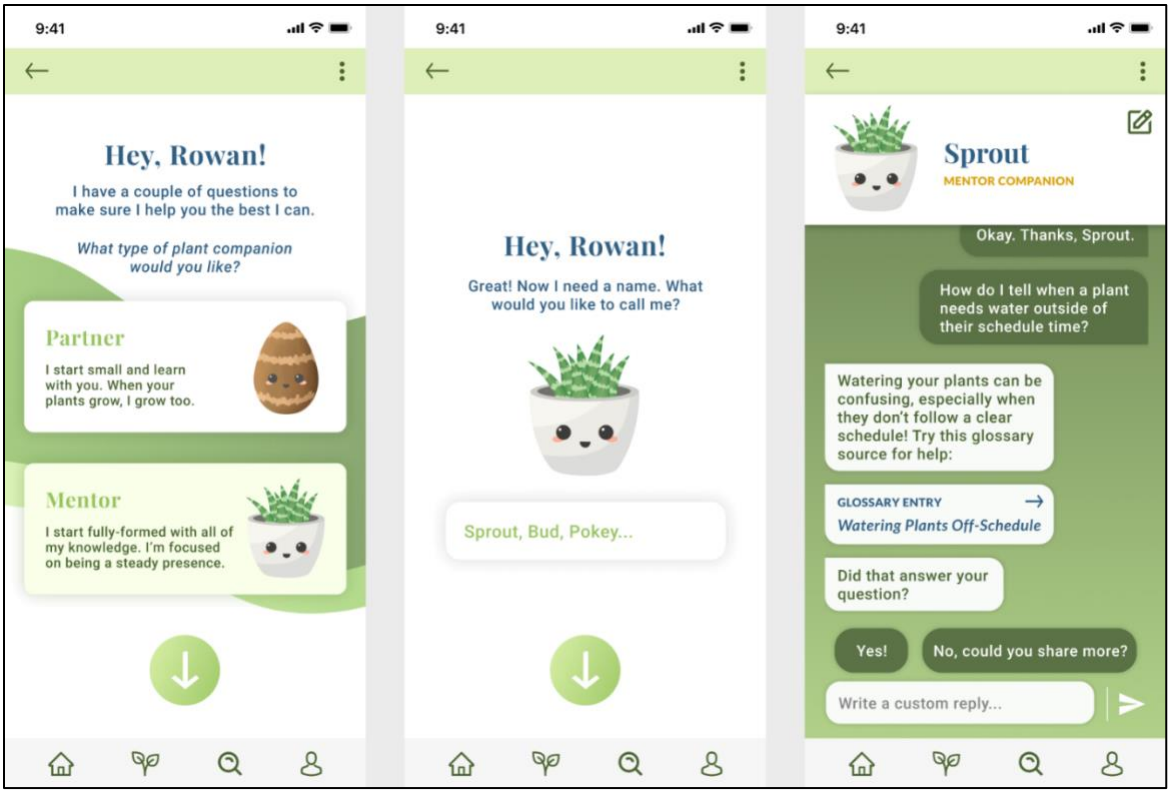
Comparison of Expert Agent and Co-Learner Agent Models



The pages that the agent inhabits must follow the style guidelines of Bloom to ensure the feature is well-integrated with the overall app. Therefore, the headers use the serif font Playfair Display (chosen for its elegant, calming ambience), and the sub-headers and body text use the san-serif font Lato (chosen for its readability at a small size). The agent's pages also follow Bloom's color guidelines: three greens, two blues, one yellow, and any minor variations thereof (Figure 1).

Figure 5

Sample Agent-Related Pages in Bloom Prototype



After reviewing the similar apps, Bloom's interface has avoided their common mistakes and improved on their ideas (Figure 5). The chat page gives a larger screen space to the agent to allow for higher levels of bonding between user and agent. Though the menu and function bars follow the style guide set by Bloom, the chat page is distinct from others in the app because of its

darker background. The user's speech bubbles use a dark background to bring more attention to the agent's replies. The prototype shows both prompted replies and a space to type a custom reply.

Once the chat interface was made, the onboarding prototype was put into motion. The agent's onboarding had four essential stages: introduction, agent role selection, user focus selection, and naming. Each page had an arrow button pointing down on the bottom of each page that users could click on; this caused the new page to push upwards onto the screen and leave the former page behind, giving the user a sense of progression. The introduction used a clean design with a simple explanation and no identifying photo, since the role and associated design had not yet been picked.

The agent role selection page explained the two roles in audience-friendly terms. The agent explains that it has a few questions to improve the user's experience, then asks what type of plant companion the user would like. The user is given two options: Partner ("I start small and learn with you. When your plants grow, I grow too.") and Mentor ("I start fully formed with all of my knowledge. I'm focused on being a steady presence.") to represent the co-learner and expert roles, respectively. The short descriptions attempt to catch what the interview subjects defined as most important—progression in the Partner and stability in the Mentor. When a user selects an option, the tile turns a pale green to indicate a successful selection, and they can click the arrow button to continue.

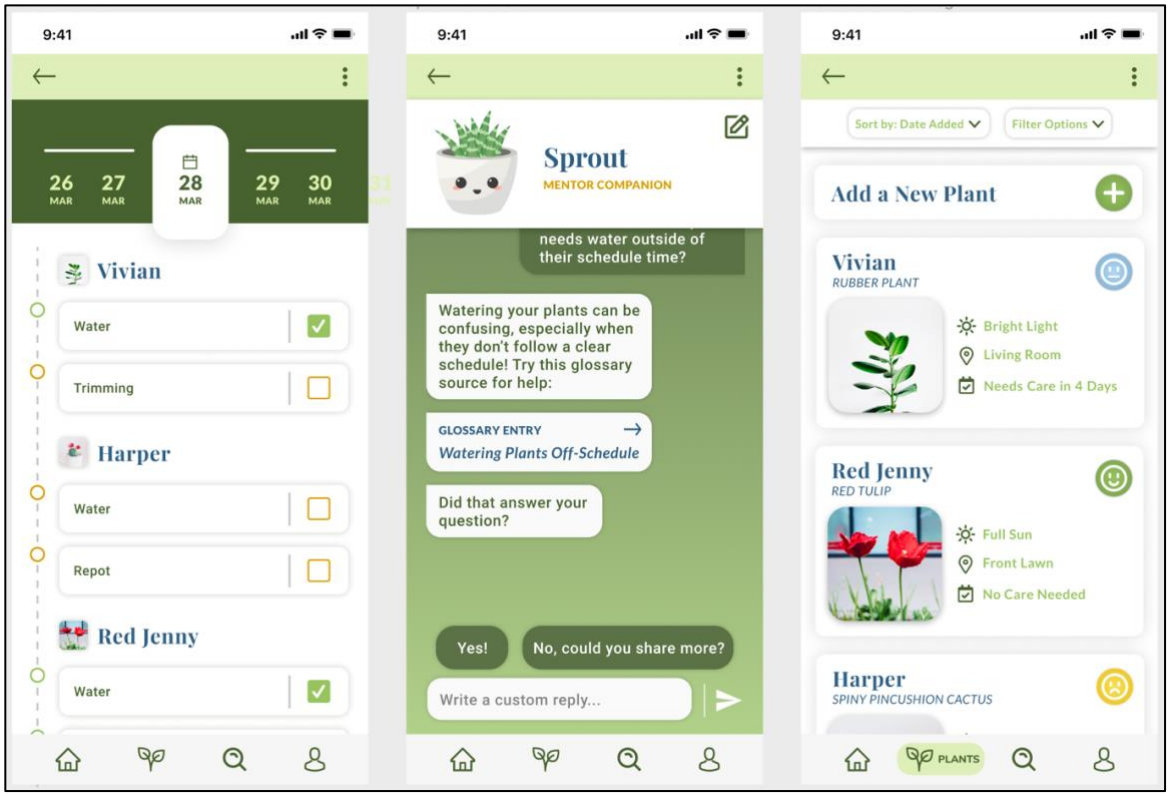
The following page asks what areas of plant care the user wants to focus on. This page was created after seeing the variety of reasons interview and survey subjects had for owning and caring for plants, as well as the most common challenges they faced. The page includes options such as Routine ("Schedules? Never heard of them."), Motivation ("Some days are harder than

others."), Learning Terms ("Should I know the difference between an annual and a perennial?"), and Tips ("How much water is too much water?"). Users select any tiles they think apply to their situation, each one turning pale green as they go, and click the arrow button when they are finished.

The final page before the chat function is introduced is the naming page. As planned in the survey's discussion, the user is able to type in their own name, but several names are suggested for them in the text entry space, beginning with Sprout. This will allow creativity for those who want to customize their agent further but prompts unsure users with the survey's well-received options. Once the name is entered, the final green arrow can be clicked to move into the chat interface.

Figure 6

Agent-Related Page (Middle) and General App-Related Pages (Left, Right)



All pages related to the agent were designed with the full app prototype in mind. Users should theoretically be able to move throughout Bloom with no differences noted between the functioning of the original prototype and its addition of a pedagogical agent. The access for the agent was provided in the top bar of every app page, allowing users to communicate with the agent easily. Figure 6 shows the Bloom chat page in comparison to other pages prototyped primarily by the author.

Conclusion

Keller's (2009) ARCS Model of Motivational Design has been used as a basis for the agent's theoretical assessment. Bloom's agent has been designed to stimulate users' curiosity through its appealing design and unique presence; no other plant management app on Android or iPhone platforms had a pedagogical agent integrated with its interface, which will make Bloom stand out to users. The agent bridges the gap between the users' goals (primarily to keep their plants alive through schedules and to learn more about plants) and the product's context (plant care management) by acting as the method for users' schedule reminders and as a source of information or guidance for the user. Allowing the users to select their desired agent role helps ensure that the level of conviction the agent brings to the user is the appropriate amount, avoiding overwhelming doubtful users with an expert role and avoiding pushing confident users into arrogance with a partner role. This design therefore meets the requirements of Attention, Relevance, and Confidence. One can hope that long-term use of Bloom and its agent would bring fulfillment to the users and continue to foster their desire to use the product, achieving the fourth requirement of Satisfaction. With these requirements met, Bloom's pedagogical agent should in theory motivate a user to learn and engage with the app.

There is still much to learn about pedagogical agents, and more than could be learned about Bloom's agent in particular. The next phase of this research project would ideally focus on user testing—the gather of feedback from users regarding the app's effectiveness. Further research could be conducted on different model roles, such as those based on social interaction theory or Social-Cognitive Theory, and the ways users react to them to see if a stronger establishment for pedagogical agents can be found. Studying how the selected agent designs would be received by other ages—such as minors—would provide more information on how different age groups could react to design styles (for instance, children may have preferred Design B, the most cartoon-based design of the four).

This research project makes clear that pedagogical agents can result in stronger emotional bonding and a longevity of use that apps based purely on function lack. Users desire a connection they can empathize with, and they find purpose in virtual social interaction that emulates face-to-face dynamics. Fulfilling underlying social and emotional desires in user experience design can be achieved through the creation of characters or agents, adding depth to the application or interface. Creating the pedagogical agent made Bloom a unique and desirable app that can both assist with user functions and connect with users to increase their self-efficacy and satisfaction with the product.

References

Baylor, A. (2009). Promoting motivation with virtual agents and avatars: Role of visual presence and appearance. *Philosophical Transactions: Biological Sciences, 364*(1535), 3559-3565. doi:10.1098/rstb.2009.0148

Baylor, A. (2011). The design of motivational agents and avatars. *Educational Technology Research & Development, 59*(2), 291-300. doi:10.1007/s11423-011-9196-3

Baylor, A. & Kim, Y. (2005). Simulating instructional roles through pedagogical agents. *International Journal of Artificial Intelligence in Education, (15)*1, 95-115.

Choi, S., & Clark, R. E. (2005). Five design principles for experiments on the effects of animated pedagogical agents. *Journal of Educational Computing Research, 32*(3), 209-225. doi:10.2190/7LRM-3BR2-44GW-9QQY

Cooper, A. (2014). *About face: The essentials of interactive design*. Wiley.

Craig, S. D., Gholson, B., & Driscoll, D. M. (2002). Animated pedagogical agents in multimedia educational environments: Effects of agent properties, picture features and redundancy. *Journal of Educational Psychology, 94*(2), 428–434. doi:10.1037/0022-0663.94.2.428

Ebbers, S. J. (2007). *The impact of social model agent type (coping, mastery) and social interaction type (vicarious, direct) on learner motivation, attitudes, social comparisons, affect and learning performance.* [Unpublished PhD dissertation]. Florida State University.

Karreman, J., & Loorbach, N. (2013). Use and effect of motivational elements in user instructions: What we do and don't know. *IEEE International Professional Communication 2013 Conference,* 1-6. doi:10.1109/IPCC.2013.6623940

Kim, Y., & Baylor, A. (2006). A social-cognitive framework for pedagogical agents as learning companions. *Educational Technology Research and Development*, *54*(6), 569-596. doi: 10.1007/s11423-006-0637-3

Keller, J. M. (2009). *Motivational design for learning and performance: The ARCS model approach.* Springer.

Liew, T. W., Mat Zin. N. A., & Sahari, N. (2017). Exploring the affective, motivational and cognitive effects of pedagogical agent enthusiasm in a multimedia learning environment. *Human-Centric Computing and Information Sciences, 7*(1), 1-21. doi:10.1186/s13673-017-0089-2

Luka, Inc. (2020). *Replika: My AI friend* (Version 4.1.05) [Mobile app]. Google Play Store. https://play.google.com/store/apps/details?id=ai.replika.app&hl=en_US

Woebot Labs. (2020). *Woebot: Your self-care expert* (Version 3.17.12) [Mobile app]. Google Play Store. https://play.google.com/store/apps/details?id=com.woebot&hl=en_US

Touchkin. (2020). *Wysa: Stress, depression & anxiety therapy chatbot* (Version 1.5.9) [Mobile app]. Google Play Store. https://play.google.com/store/apps/details?id=bot.touchkin&hl=en_US

Yu, Y. (2015). *The role a motivational agent plays: The effects of a co-learner agent and an expert agent.* [Unpublished master's thesis]. University of Twente.

Appendix A – Research Interview Questions

Overview Questions

1. What got you into plants/plant care?
2. What do you enjoy about plants/owning plants?
3. What challenges do you face when caring for your plants?
4. Do you take care of your plants on your own or with others? Why?

Emotional Reaction Questions

1. How do you feel when you take care of your plant(s)?
2. How do you feel when you notice your plant has grown?
3. How do you feel when you think you've made a mistake with your plant care?
    a. What do you do?
4. Do you think plants affect you or your environment? If so, how?

Motivation Questions

1. What motivates you in general?
2. What motivates you to care for your plant(s)?

Pedagogical Agent Questions

1. How would you expect the presence of a pedagogical agent change to your experience of the Bloom app?
2. How do you feel about the idea of a pedagogical agent being added to the Bloom app?
3. How do you feel about an expert-oriented pedagogical agent versus a co-learner-oriented pedagogical agent being added to the Bloom App?

Appendix B – Survey Questions

Introduction Page

1. Do you own/care for plants?

Design Page

1. Rate the four design styles based on aesthetic appearance, **1** being **aesthetically unappealing**, **5** being **aesthetically neutral**, and **10** being **highly aesthetically pleasing**.
2. Rate the four design styles based on how negative/positive they make you feel, **1** being **negative**, **5** being **neutral**, and **10** being **positive**.
3. Rate the four design styles based on how well you think they fit with the above color scheme, **1** being **not at all**, **5** being **neutral**, and **10** being **very well**.
4. If you were to interact with one of these designs on a weekly basis, could you rank your preference of designs, with **#1** being the one you would **most prefer** to see weekly and the **#4** being the one you would **least prefer** to see weekly?
5. Is there any specific feedback on any of the designs that you would like to provide? (Such as aspects you liked and disliked, or things you thought should change.)
6. How satisfied are you with the following potential names for the design(s)?
7. If you have an alternative name you would like to suggest, you may do so here.

Plant Experience Page

1. What do you enjoy about plants/owning plants?
2. Do you think owning plants/caring for your plants affects your mood? If so, how?
3. What motivates you to care for your plant(s)?