Cultivating Green Thumbs: A Plant Care System for Enthusiasts

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ABSTRACT

The learning system aims to teach botanic hobbyist how to care for specific plant species. It does so by guiding the user through projects, monitoring their progress, and providing adaptive feedback. The user will learn what the plants' needs are and how to regulate the environment to fit these needs. We collect data which is a combination of self-reports and sensors.

After an initial intake assessment, the system will recommend a list of plants based on the user's current knowledge level and environment. If the user is a complete novice, the system will provide beginner-friendly plants to grow. The user will get information about the plant and how to take care of its needs. Over time, the system will recommend specific actions, provide additional materials, and assess the proficiency of particular knowledge components based on the input gathered from both the user-reports and sensors.

1 INTRODUCTION

Plant care hobbies, whether it be growing in-door plants or outdoor gardening, are seen positively by many. Aside from improving the environment with more plants being grown and cared for, these activities are reported to be therapeutic in nature, benefiting one's mental and physical health [1]. Yet many who are drawn to plant care are discouraged initially, with one survey citing that nearly 50% of the participated millennials said that they do not know how to take care of plants, nor are they confident in their ability to do so [7]. Thus we aim to design a plant care tutoring system that can adapt to its users' current experience and projects. Taken into account how many plants and flora species out there, the system seeks to focus on species that can reliably and commonly be grown in-door, and/or that do not require much land estate.

1.1 The System

The learning system will start by asking the user if they would like to take care of a specific plant, or whether they would like to start off with a general start. In both cases the system will assess their current competence level by doing a pre-quiz about their botanical knowledge. Moreover, they will be asked to share their location, so the system can get information about their environment. Environmental information and time is important, as the system can determine the difficulty level of a plant based on the current environment of the user. A novice user in Scandinavia during the winter, for example, would get recommended a plant that does not need a lot of light since there is almost no sunlight during this time of the year. See figure 1 for a global overview of how the system works.

1.2 Learning Material

The learning material consist of a range of species with associated difficulties in specific 'branches', along which they are organised. These branches are based on a plants environmental needs, like (direct) light, water, soil composition, nutrients, humidity, and ambient temperature. The narrower the required range for a given branch of a species and the further the range is from the user's typical environment, the harder the difficulty of the plant becomes.

When a user starts with a plant, the system shall provide them an overview of its properties. This written content includes the name of the plant and the assumed difficulty of taking care of it. If the user decides to try growing the plant, they can read the light, water, soil and other important requirements for the plant.

After the user starts growing the plant they can report any problems or questions. The second type or the educational material will examine the feedback from the soil and light sensors and the direct feedback from the user and give advice accordingly.

1.3 Adaptation

The system adapts on three levels:

- Adapt to the current level of knowledge: when the user starts using the system, it assesses the current level of the user by means of a generic questionnaire and a randomized set of questions from the 'question bank'. Depending on the user's responses and the presented questions' difficulty, the system can calibrate to the user's competence level. The type of questions include multiple choice questions based on images of healthy, unhealthy, or diseased plants.
- Adapt to the user's goal: they can decide whether they want to move on to more difficult plants or they are satisfied with the current plant projects that they have. This will be assessed towards the end based on the self-report on the plant's growth given by the learners. If the self-report shows that the plant is in a healthy state, then the system will ask if the users want to grow more difficult plants, after which a series of more difficult plants will be provided for them to choose. If the users are already happy with their current progress and do not seek for additional challenges or new plants to grow, they can simply stop at this point.
- Adapt to the user's attributes: specifically their location and environmental circumstances. Factors like humidity,

temperature, daylight, etc. are greatly influenced by this user-specific attribute and can be used to alter the difficulty levels of—and thus suggested—species.

2 LITERATURE REVIEW

Understanding how plants respond to environmental factors, such as temperature, humidity, light, and nutrient availability, is a critical aspect of plant care. This knowledge can help in optimizing plant care practices. Sensors can help in measuring these environmental factors. Specifically abiotic stresses (non-living or environmental factors, like heat and drought) can be maintained by using sensor data. In recent years, advances in sensor technology have led to the development of wireless and remote sensing networks that enable continuous data collection, making it easier to monitor and manage environmental conditions [6]. For example temperature affects seed germination, flowering, composting, and various plant growth processes. Therefore using sensors can help in maintaining the optimal temperature for the plant [8]. Additionally, sensor data can be integrated with other data sources, such as results of a test and user knowledge, to provide a more comprehensive understanding of environmental circumstances and the progress of the user.

However, one limitation of these sensors is that multiple stresses (temperature, humidity, light etc.) can trigger similar responses in plants. This makes it difficult to pinpoint the exact stressor responsible for a particular response from the plant. As a result, relying solely on these sensors to diagnose a plant's health may lead to incorrect conclusions [3].

It's essential to grasp how users are progressing in their learning journey. One way to monitor this is through self-reports, where users share their actions and provide updates on the plant's well-being.

Nevertheless, self-reporting comes with its constraints. A primary concern is the user's self-perception. Users may believe they are excelling in plant care, while the plants may actually be experiencing significant stress. Conversely, users might underestimate their performance, even though the plants are thriving and blossoming. Another potential issue is that users might not provide truthful responses because they aim to demonstrate that they possess the necessary skills or wish to present themselves in a more favorable light. Furthermore, users may become less diligent over time because they find it tedious to repeatedly complete self-reports [4].

3 SYSTEM DESIGN AND IMPLEMENTATION

3.1 Domain model

The knowledge domain of the proposed system is firmly rooted in the field of horticulture. To take care of plants, the user requires both declarative—facts and concepts—and procedural knowledge—skills and know-how. For the former, think of factual properties of specific plants such as how much water it requires and what soil composition it needs. For the latter, examples are how apply water to the plant and prepare its soil for optimal growth. Each plant species will be its own subdomain, see appendix 6.1 for several examples. Overall, these facts and skills are assigned to five *main knowledge components*, that include several sub-skills that the user can learn one-by-one:

(1) **Watering**:
- required amount of water
- ideal temperature of the water
- watering method

(2) **Soil and Compost**:
- required amount of compost
- compost and soil composition and how the minerals are used by the plant

(3) **Lighting**:
- the optimal number of sunny hours
- whether the plant likes direct sunlight

(4) **Temperature regulation**:
- adequate temperature for the plant to grow or for the plant to bloom
- whether it is dependent on the seasons or manually controlled

(5) **Health diagnostics**:
- possible diseases that the plant may contract or the plant is prone to
- recognise multiple different symptoms
- being able to plan the treatment

By introducing these skills and sub-skills, the granularity of each of the five main knowledge components were increased, resulting in better system-adaptivity, more specific feedback and a more structured way of learning for the user.

The relations between these knowledge components are largely taxonomic and propaedeutic. Consider, again, watering, direct application of water to the soil and misting water on a plant's leaves are both 'watering operations'. Furthermore, in order to remedy some afflictions, a plant may require re-potting, for which soil and composting knowledge are required.

3.2 Content model

The content model of a system defines what knowledge a user can learn from each piece of learning content. For example the relationship between exercises, texts and the knowledge components they cover. For the plant care system multiple knowledge components exist. In the following subsections a deeper understanding will be provided about these knowledge components and how they are structured and related to the learning material.

3.2.1 Knowledge components of learning material. The plant care learning system primarily uses two types of knowledge components, namely declarative and procedural. For example for the knowledge component temperature, during a quiz the student might be wrong about the optimal temperature for snake plants. In that case feedback will be given in the following format: *The optimal temperature range for snake plants is between 21 and 32°C. However, prolonged exposure to temperatures below 10°C can cause cold injury to the plant.* This allows the user to learn facts and concepts about their specific plant for each knowledge component.

Yet such a knowledge can also be learned procedurally; using the previous example, the user can learn over time which temperature is most suited for a specific plant if they are actively growing it. For some knowledge components such as adding compost and managing soil composition, while stating what composts are best and what the soil composition should consist of are helpful, the user will eventually develop the associated skills and sub-skills through practical application.

3.2.2 Structure of content model. Most of the knowledge components will consist of multiple items. However, for lighting and temperature, they are limited to a few. For example, within the knowledge component of health diagnostics, multiple images of symptoms of plant diseases, like discolored leaves or root rot, will be shown to the user. This will make sure that they recognize when their plant is in trouble. For temperature this is just limited to telling the user what the optimal conditions are for their plant species.

Thus the following structure will occur for each plant species, see tables **??**, **??**, **??**, **??**, **??**, **??** in the appendix to view the learning material of each plant species and their knowledge components. This results in the learning material being organised in a structured manner.

A user undertaking any plant project develops horticulture skills 'on the go' until the project is considered done—i.e., after a certain amount of set time or the plant has grown to a sufficient degree. They are encouraged to report their own progress by using the plant journal where they can provide their own interpretation of how their ongoing projects are faring.

Furthermore the learning material is organised in a way where the users are challenged with an increased difficulty of plant care within their own progress. This is because the learning material is ordered in difficulty, see tables 1 in the appendix where each plant species and their knowledge components have a difficulty score.

3.3 user model

3.3.1 Modeling approach. In our adaptive educational plant care application, the user model is designed to assess and continuously update the user's knowledge and skills related to plant care. The user model employs an overlay approach, wherein learning how to care for specific plants contributes to different skills and their associated sub-skills. These include watering, adding compost and managing soil composition, lighting, temperature management, and health diagnostics. Each of these skills is assigned a score that reflects the user's proficiency in that area.

3.3.2 Uncertainty. Dealing with uncertainty is a critical aspect of our user model. Several sources of uncertainty are considered:

1. **Reliance on User Self-Report:** Since the application doesn't physically see the user's plants, we rely on the user's self-report, which may not always be entirely accurate. Users may misjudge or overlook certain aspects of their plants' care. Also it is possible that the user does not fill in the plant journal of does not log a problem report, so the system's self-report that will be missing.
2. **Uncontrolled Environmental Changes:** External factors such as weather can impact plant care results, but these are unrelated to the user's competency. These uncontrollable changes can introduce noise into the assessment process.
3. **Open-Ended Success Criteria:** Success in plant care can vary from person to person and depends on individual goals and definitions of success. To address this, we provide users with customizable metrics, allowing them to set their own success criteria.

To manage uncertainty, our user model calculates probabilities based on the user's scores in different skills. If a plant's assumed difficulty in these skills matches or is lower than the user's scores, the probability of the user successfully caring for the plant is high. Inversely, if the user's proficiency falls short of a plant's required skill levels, it decreases. Nevertheless, users have the opportunity to gain more points if they can successfully care for plants with higher difficulty levels, thereby improving their skills.

In addition to addressing uncertainty through the methods mentioned earlier, leveraging various sensors provides an effective means of gathering accurate information about the plants. These sensors include humidity sensors, lighting sensors, thermometers, and soil sensors that measure moisture, pH, NPK (Nitrogen, Phosphorus, Potassium), and conductivity levels. Integrating data from these sensors with the information reported by the users further enhances our ability to assess plant health and care accuracy.

If both the user's self-reported feedback and the sensor data align, indicating optimal plant conditions, we provide positive reinforcement, commending the user's efforts.

However, in cases where the user's feedback is positive, but the sensor data indicates issues, we guide the user by acknowledging their efforts with a "Good job, but please check your watering sensor because it shows that your plant needs some water." They might see that the sensor was right, however if the user thinks that the sensor is broken they can ask for ways to check if the sensor works well.

If the user reports problems and the sensors detect corresponding irregularities, we offer specific guidance to address the issues: "Your sensors show (...), so the cause of the reported problem might be (...)." This information helps the user troubleshoot and take appropriate action.

In scenarios where the user reports problems, but all sensors indicate correct values we can provide information about he possible diseases of the plant. In cases where non of the disease symptoms are visible on the plant, we suspect sensor malfunction. We guide the user on potential checks, such as placing the humidity checker in water, to ascertain if the sensors are functioning correctly and prompt them to verify and rectify any sensor-related issues.

3.3.3 Score calculation. To evaluate the user, the system uses scores to keep track of their current progress. A single skill can reach a maximum score of 100 points. Take watering for example, if a user regularly waters and maintains the moisture level in the optimal range over time, it is an indicator that they are doing well in this specific aspect. As a result, the user's points for this skill will increase. Answering correctly on questions related to watering in the plants-specific quiz also earns some points towards skill mastery. If poor performance is reflected in the self-report, through the sensors, or through the quizzes, no points are given.

For each ongoing plant project, the system back-end will also track the scores of all skills. This is used to calculate how well a user is doing skill-wise for a specific plant species. However, only the scores of overall plant care skills are reported back to the user.

3.3.4 Cold-start problem. To address the cold-start problem, we implement a comprehensive on-boarding process for new users, gauging their initial proficiency levels for the different skills. This includes a questionnaire collecting the user's:

(1) **goals:** used to determine the success criteria
(2) **prior experience:** used to estimate a user's skill proficiency

Additionally, users are presented with a test featuring images of plants and multiple-choice questions on how to care for them. These measures allow us to establish an initial understanding of the user's knowledge and preferences, enabling us to tailor the learning experience to their needs.

3.3.5 Sensors. Next to the self-reporting and testing, sensors will also be used to measure the improvement of the user. The sensory data from the sensors can provide quantitative, real-time information about the plant's environment, such as temperature, humidity, and soil moisture. These objective measurements complement the subjective self-reporting of the plant's appearance and overall condition provided by the user. By combining both types of data, a more comprehensive and accurate assessment of the plant's health can be achieved, reducing the risk of incorrect conclusions.

3.4 Instructional model

3.4.1 Pedagogical strategy. In developing an instructional model for our plant care system, we draw upon two pedagogical strategies: cognitivism and constructivism. The cognitivist approach involves systematically teaching users essential gardening and planting skills. On the other hand, constructivism emphasizes learning through direct experiences gained by caring for plants. These strategies synergize to enhance the learning process. Factual information helps in learning practical plant care skills, and with enhanced skills, the user can come across other pieces of plant knowledge that they were not aware of previously. Therefore, improvement in skills directly correlates with enhanced plant care abilities. The mastery of these skills is rated on a scale from 1 to 100, and is portrayed 1 to 10 visually for the user. See figure **??** for UI details.

3.4.2 Domain model as the bases to the pedagogical strategy. The pedagogical strategies in our learning system is tightly aligned with the domain model, which consist various aspects of plant care. Each user has plants equipped with sensors, facilitating real-time feedback on essential parameters such as watering and lighting. It strengthens the connection between theoretical knowledge and practical application, aiding in the mastery of plant care.

3.4.3 Student model's metadata on the interface. In implementing our instructional model, each user has an unique profile which is captured in the student model. For instance, if an user demonstrates proficiency in a specific skill like watering, and accurately answers related questions about this skill for a snake plant, which is an easy skill for this specific plant. Our system will recommend attempting a more challenging plant that requires more advanced watering techniques. This approach personalizes the learning process, ensuring users are consistently challenged and progressively build their expertise.

3.4.4 Content model on the user interface. The content model defines what knowledge a user can learn from each piece of learning content, enabling users to learn the theoretical information of plant care. The content model is structured in a way that allows gradual progression of skills, ensuring a progressive and logical learning path, see table 1 for the difficulty ratings of specific plants that the system provides.

One way the instructional model does this is by having the user learns hard facts through simple quizzes. See images **??** and **??** to view an example where the system responds to an incorrect answer.

Another way is the plant journal, where the system takes more of a passive role, allowing and encouraging the user to be more engaged in learning through active experience. The user's skills grow when taking care of their plants, and they can keep track of their progress using the system's provided journal. They have the chance to implement whatever knowledge they have learned from the system, and in turn they will receive feedback in the form of their plant's health.

Considering all elements above, the instructional model offers an effective approach to support the user in mastering the art of plant care. It combines a hands-on approach from the user's side, enabling active participation in plant care, with a hands-off approach from the system, which empowers users to set their own pace and take ownership in their learning journey.

3.5 Interface design

The interface is designed with focus on ease of usability, being able to convey vital information without compromising on the prototype's visual aesthetic. It uses a color palette with the main color being mossy green to evoke the gardening theme of the system, the color black and white as the background and lettering colors to highlight the content, along with other minor colors. Important details such as the sensor outputs of the user's current project or their current skill levels are always at the forefront given their priority for the user to learn effectively.

When a new user opens the application they have to register, providing information like name, e-mail address, and country. Upon completion of the profile, the user is prompted to complete questions drawn from our problem database, allowing us to gauge the initial proficiency of the user in the different skills. The problem difficulty during this on-boarding is adapted based on the correctness of the responses. At the end of the on-boarding process, the profile is created and the user can see their skills under the "My Skills" title. (figure **??**)

When the logged-in users open the application the main page is the "My Plants" page. By selecting a plant the user can process to the plant's specific page, where they can see all basic information about the plant (overview and knowledge component specific basic descriptions). On this page the user has the option to take an image-based test (figure 2), report a problem or fill in the plant journal. (figure **??**)

For further details on the interface of the prototype, please refer to the appendix.

4 EXPERIMENT DESIGN

4.1 Introduction

Our learning system adapts and provides feedback based on data collected through self-reports. The data is factual in nature, as the users report on observable and measurable traits of their growing plants—e.g. the color of the plant, its height, whether the plant leaves have spots, and how much water has been used for watering. One problem that surfaces from such method is uncertainty, where the system has no way of knowing if the self-report data is reliable or not, hindering its ability to assess and predict plant conditions. Assuming good faith—i.e. disregarding intentionally lying or omitting details in self-reporting—users can misinterpret what they observe which leads to unreliable data. While there have been studies done on the accuracy of the method within the field of education, most of them are not directly applicable here since they are about using learners' self-reported grades to predict academic grades [2, 5].

Sensors that measure crucial environmental factors, such as humidity and soil composition, are thus introduced to the system to partly address this issue. By allowing users to use sensor equipment for their plant projects, the system can then make use of data from both the self-report and sensors for better feedback. A question comes up then, that whether having sensors being managed by the users will have an effect on the their knowledge gain. At the same time, for whatever reasons, the users might not use sensors for their plant project, thus the system will have to rely solely on data from users' self-report. It would be interesting therefore to study how the system would function with and without the data input from the sensors and their effect on the users' learning. Hence we propose the following experiment, where a version of our system will be used without sensors and compare its effects on the users' learning to that of the complete one.

With regards to adaptive learning in horticulture, we aim to see if sensors are strictly required for the users to learn effectively, and this study can be the start to exploring that questions. Outside of this particular field, the results of this experiment should also help shed some light on how to improve the effectiveness of adaptive feedback in learning - whether or not the inclusion of sensors can help generate a more effective feedback for the learners.

4.2 Experiment setup

The participants are selected from a uniform population of subjects with a similar proficiency level. This population is selected based on a pre-experiment assessment. They are then divided into two groups: Group A (using the system with sensors) and Group B (using the system without sensors).

The experiment shall run for two months, during which both groups will use the system as per their assigned conditions. They shall also be provided with a plant to look after and the basic instructions of how to do so. The plant shall be suitable to the overall proficiency level of the participants and be the same species for all participants to ensure consistency.

The primary metric for evaluation will be the difference in assessment scores between the two groups, indicating knowledge gain. This data will help determine which group exhibits a significantly higher increase in plant care knowledge.

With the proposed experiment, we aim to reject the following null-hypothesis: the inclusion or exclusion of sensor data in our system does not impact the user's knowledge gain. The user's self-report is structured around answering closed-ended questions—i.e. observable facts about the plant and the user's plant care actions and schedule—allowing the system to make more accurate inferences. Yet, by removing sensors, it means eliminating additional data that the system can use to generate a more accurate feedback, which should lead to the users having a more difficult time learning plant care, and thus result in lower possible knowledge gain.

4.3 Analysis method and expectations

The key data we collect is the proficiency levels of the participants at the pre- and post-experiment assessment. This allows us to take the difference and run a (one-sample) Student's t-test on the two groups in order to establish whether there is a significant difference between the two.

Analysis and evaluation steps:

(1) Collect pre- and post-experiment assessment scores for both Group A (with sensors) and Group B (without sensors).
(2) Calculate the proficiency gain:

$$Score_{post} - Score_{pre} = proficiency\ gain$$

(3) Calculate the mean proficiency gain for each group.
(4) Calculate the standard deviation for each group.
(5) Test for normality using an Anderson-Darling test.
(6) Assuming, normality, perform a one-sided Student's t-test with a significance level of 0.05 to determine if there is a significant difference in knowledge gain between the two groups.

The resulting p-value from this t-test will allow us to either accept or reject the null-hypothesis. Rejecting the hypothesis means that there is a statistically significant difference in proficiency gain between the groups. This is what we would expect if the addition of sensory data truly allows our system to adapt more appropriately to the user.

5 CONCLUSION

5.1 Summary

The report presents an innovative learning system designed to assist botanic hobbyists in nurturing specific plant species. This system is not just a tool for plant care but an educational platform that guides users through a series of projects, offering adaptive feedback based on their progress and unique environmental conditions. Key to its functionality is the integration of data from both user observations and sensor inputs, such as humidity measures, temperature, and soil composition, which enables a personalized and interactive learning experience.

At the core of the system is a user-friendly interface tailored especially for hobbyist plant caretakers. It recommends plants that align with the user's current knowledge level and environmental setup, gradually increasing in complexity as the user's skills develop. This progressive learning approach is complemented by a rich repository of educational content organized into distinct branches, each reflecting specific environmental needs like light, water, soil composition, and temperature. Plants are suggested to the user based on the difficulty of caring (based on these factors), ensuring a challenging yet achievable learning curve for the user.

The experiment design for the application involves users engaging with the system in their homes over an extended period, caring for their plants. Participants, varying in plant care experience, use the system to receive guidance, monitor their plants' health, and log their care activities. The experiment collects data from two main sources: user self-reports in the form of plant journals and problem reports, and sensor data measuring environmental conditions to increase the accuracy of the self-reported data. Both data are used to personalize the learning experience and to provide tailored plant care advice. The proposed experiment assesses how the effectiveness of the system is influenced by the sensory data by conducting A/B testing where one of the groups has access to the sensory data and the other does not. The effectiveness of the system is assessed through a post-experiment test, designed to evaluate the knowledge gained by the users.

5.2 Limitations

In the development and implementation of the plant care system, several limitations have emerged, each playing a critical role in the overall effectiveness and educational value of the tool. **Reliance on Self-Reported Data:** A fundamental limitation lies in the application's dependence on self-reported data from users. This data, derived from plant journals and problem reports, is inherently subjective. Novice users, lacking in experience and knowledge about plant care, are particularly prone to providing inaccurate or incomplete information. Their inability to correctly identify signs of plant health or distress can significantly skew the data fed into the machine learning model, leading to less accurate predictions and advice.

Variability in User Engagement and Environmental Conditions: Conducting the experiment in users' homes over an extended period introduces considerable variability. User engagement with the application differs widely; some users may engage with it diligently, while others less so. This inconsistency in usage patterns affects the quality and quantity of data collected, which in turn influences the learning outcomes and the predictive model's performance. Moreover, environmental factors such as pests, diseases, or unique growing conditions, which are beyond the scope of our study, also impact plant health. These factors not only affect the plant's condition but also have indirect consequences on the educational experience of the users. For instance, a thriving plant might enhance learning enthusiasm, whereas a struggling plant could serve as a practical, albeit challenging, learning opportunity.

Challenges in Pre/Post-Experiment Assessment: The assessment conducted before and after the experiment to gauge learning outcomes also presents challenges. User performance in these assessments might be influenced more by their comfort with test-taking rather than their actual knowledge gain. Furthermore, the range of questions in the assessment might not fully encompass the diverse learning experiences of the users. This limitation is a reflection of the inherent difficulty in creating a comprehensive and representative assessment that accurately measures the intended learning outcomes.

Influence of Sensor Data on Educational Outcomes: The inclusion of sensor data, while intended to enhance plant care and learning, introduces another layer of complexity. By providing users with real-time data on environmental conditions, the sensors offer an additional, indirect, learning resource. However, this can lead to disparities in the learning experiences of users, particularly in how they interpret and utilize this data. Although our experimental design attempts to minimize this by excluding sensor-specific content from the post-experiment assessments, the mere exposure to such data can inadvertently influence the learning curve of the users who have access to it.

5.3 Future Work

Scheduling and Notifications: One of the most common hurdles for plant owners is maintaining a consistent care routine. To address this, we could introduce a feature that allows users to create a schedule for specific care activities, such as watering and pruning, for each plant. The application would provide information about the plants and best practices for scheduling to support the user in creating such a schedule. It would then send timely push notifications as reminders based in the created timetable. This functionality would not only help in preventing plant neglect but also encourage regular interaction with the system. It's a step towards transforming routine care into an engaging learning experience, reinforcing the understanding of each plant's unique needs.

Leveraging Advanced AI for Text Analysis: Currently, our application primarily processes structured data inputs. However, the wealth of information hidden in free text reports from users remains largely untapped. We plan to integrate advanced artificial intelligence, particularly large language models (LLMs), to analyze and interpret these textual inputs. This move could enhance the quality of data being fed into our system, making our model more robust.

Community and Social Features: The power of community and social interaction in learning and engagement cannot be overstated. We aim to introduce features that allow users to share images of their plants with the community. This not only serves as a motivation for increased engagement but also creates a visual diary of their plant care journey. Additionally, a forum for users to post pictures of afflicted or problematic plants can be a valuable resource. It would enable peer-to-peer support and advice, fostering a collaborative and supportive learning environment.

Experimental research to evaluate and update the application: To further enhance the application, we propose conducting experimental research focusing on user interface design and content effectiveness. By exploring different interface layouts and interactive elements, we can determine the most user-friendly and efficient way to present information. Additionally, experimenting with various types of educational content, like videos and articles, will help us identify what resonates most with our users. These experiments are crucial in tailoring the app not just to the needs of the plants, but to the preferences and learning styles of the users.

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6 APPENDIX

6.1 Examples of plants with different difficulty levels

Easy to Take Care of: Snake Plant (*Sansevieria trifasciata*):

- Snake plants are known for their durability and ability to thrive in various indoor conditions.
- They tolerate low light and irregular watering, making them perfect for busy individuals or those new to gardening.
- Snake plants can also help purify the air by removing toxins, making them a great choice for improving indoor air quality.

Moderate Care: Spider Plant (*Chlorophytum comosum*):

- Spider plants are popular houseplants known for their cascading leaves and easy propagation.
- They prefer indirect sunlight and well-drained soil, requiring moderate watering and occasional fertilization.
- Spider plants can produce "spiderettes" (baby plants) that can be potted separately, making them a great choice for sharing with friends or expanding your indoor garden.

Harder to Take Care of: Orchids (*Phalaenopsis* spp.):

- Orchids are beautiful and elegant flowering plants but require specific care and attention.
- They need proper humidity, indirect sunlight, and a well-ventilated environment. Overwatering can be detrimental to their health.
- While orchids can be a bit more challenging to grow compared to some other plants, with proper care and patience, they can reward you with stunning blooms.

6.2 Examples of growing vegetables

Water Spinach

- A common but popular type of vegetables often found in Southeast Asia cuisine.
- Easy to plant from seeds and given enough sunlight, water, and some compost, water spinach can be harvested after roughly 4 weeks, which makes it suitable to cultivate almost year round. Soil quality does not matter for beginners.
- Can attract insects depending on the area which the users may have to learn how to deal with.

Potatoes

- A staple in many cuisines around the world, and is a vegetable many cannot live without.
- Usually planted in late Summer or early Spring. Depending on the cultivars, the conditions to grow may vary, and the time to harvest can differ too, which usually takes a few months.
- When planting and growing potatoes, details such as the pH level of the soil and how much water should one use for each phase are important to take note.

Figure 1: Schema of plan

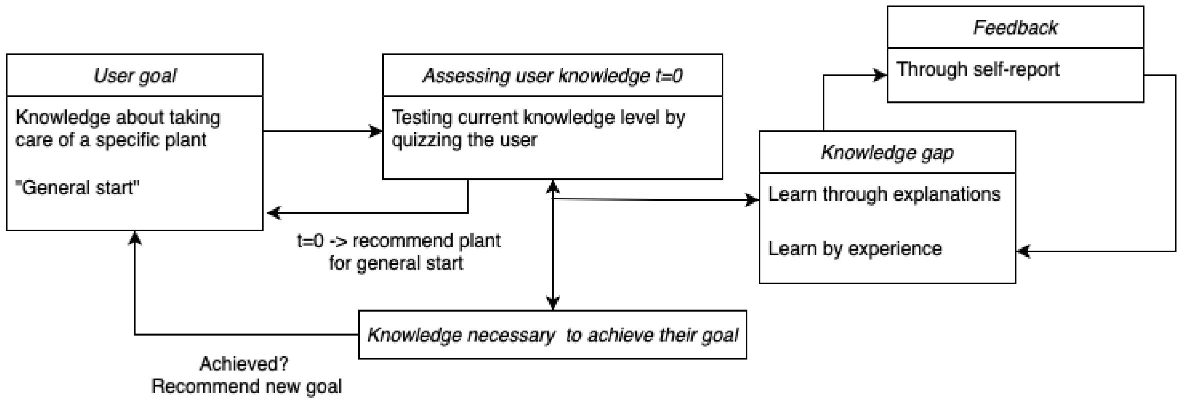
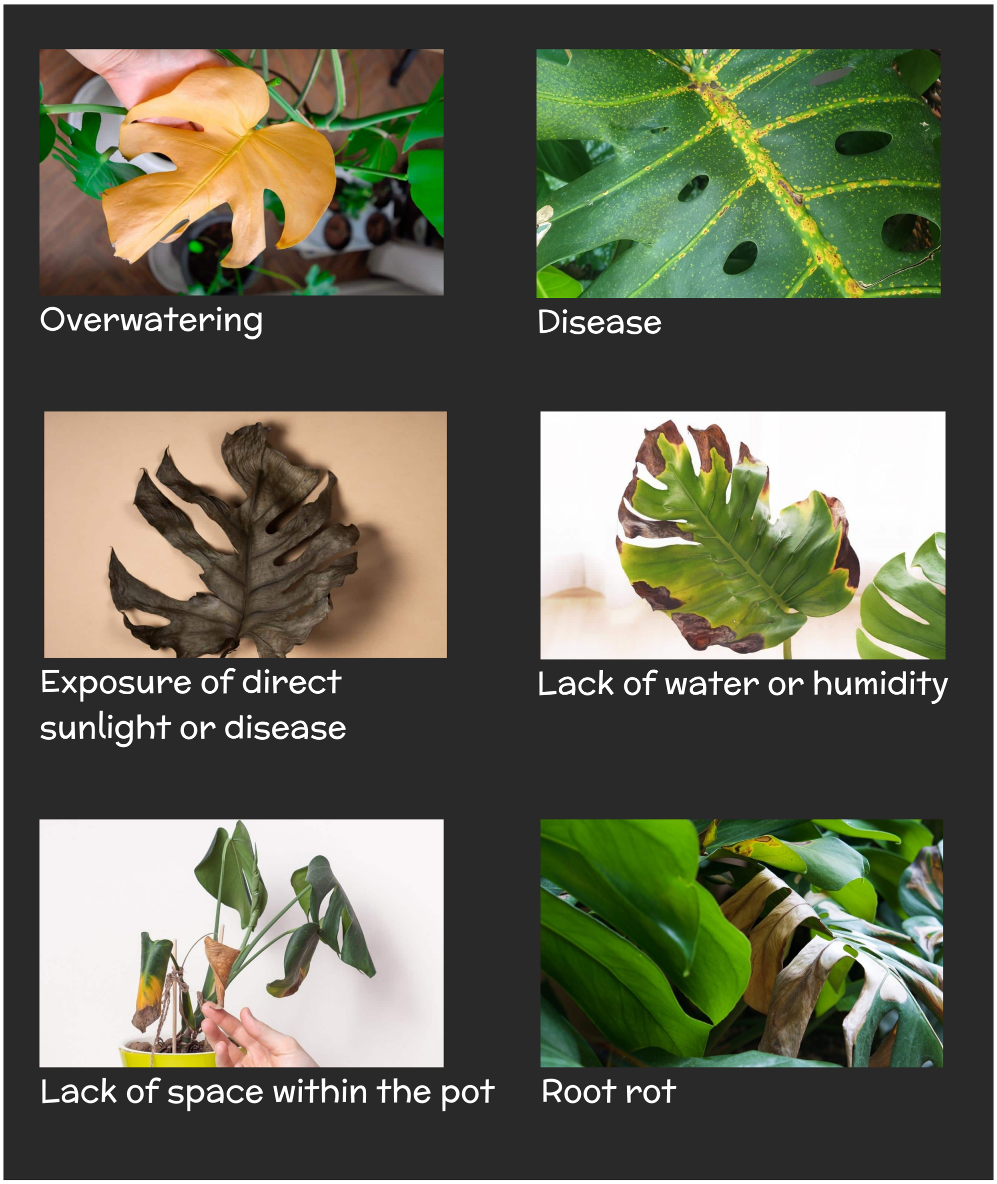
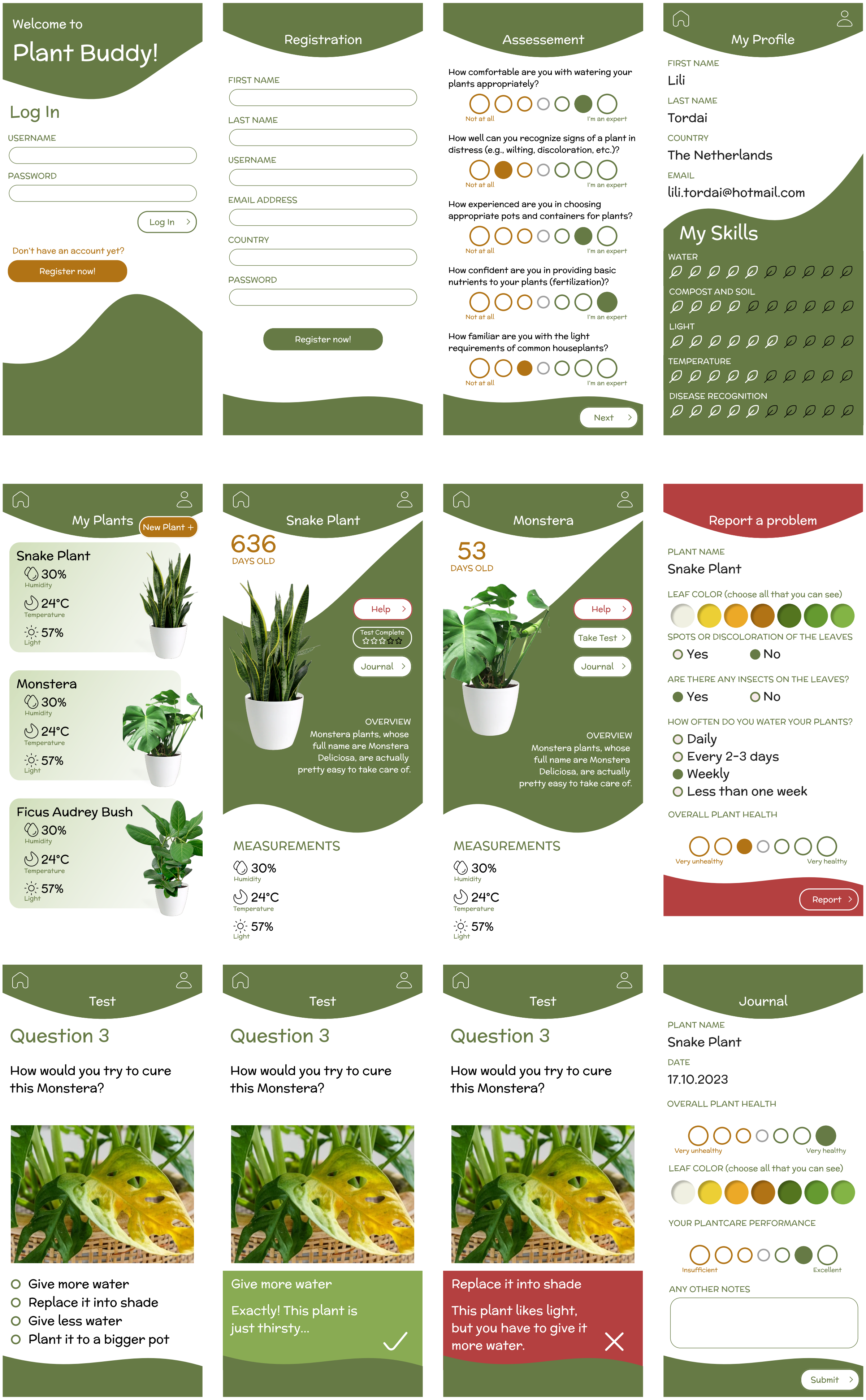


Table 1: Difficulty Ratings for skills and plant species

Plant Species	Watering	Light	Soil	Health diagnostics	Temperature
Snake Plant	1	1	2	3	5
Aloe Vera	4	4	3	3	2
Fiddle Leaf Fig (*Ficus lyrata*)	4	4	5	4	5
Peace Lily (*Spathiphyllum*)	7	6	5	7	6
Orchid (Various genera)	7	8	8	5	8
Bonsai (Various tree species)	8	6	9	9	2

Figure 2: Image-test example with correct answers: What causes the symptoms of this Monstera plant?




Welcome to
Plant Buddy!
Log In
USERNAME
PASSWORD
Log In
Don't have an account yet?
Register now!
Registration
FIRST NAME
LAST NAME
USERNAME
EMAIL ADDRESS
COUNTRY
PASSWORD
Register now!
Assessement
How comfortable are you with watering your plants appropriately?
Not at all
I'm an expert
How well can you recognize signs of a plant in distress (e.g., wilting, discoloration, etc.)?
Not at all
I'm an expert
How experienced are you in choosing appropriate pots and containers for plants?
Not at all
I'm an expert
How confident are you in providing basic nutrients to your plants (fertilization)?
Not at all
I'm an expert
How familiar are you with the light requirements of common houseplants?
Not at all
I'm an expert
Next
My Profile
FIRST NAME
Lili
LAST NAME
Tordai
COUNTRY
The Netherlands
EMAIL
lili.tordai@hotmail.com
My Skills
WATER
COMPOST AND SOIL
LIGHT
TEMPERATURE
DISEASE RECOGNITION
My Plants
New Plant +
Snake Plant
30%
Humidity
24°C
Temperature
57%
Light
Monstera
30%
Humidity
24°C
Temperature
57%
Light
Ficus Audrey Bush
30%
Humidity
24°C
Temperature
57%
Light
Snake Plant
636
DAYS OLD
Help
Test Complete
Journal
OVERVIEW
Monstera plants, whose full name are Monstera Deliciosa, are actually pretty easy to take care of.
MEASUREMENTS
30%
Humidity
24°C
Temperature
57%
Light
Monstera
53
DAYS OLD
Help
Take Test
Journal
OVERVIEW
Monstera plants, whose full name are Monstera Deliciosa, are actually pretty easy to take care of.
MEASUREMENTS
30%
Humidity
24°C
Temperature
57%
Light
Report a problem
PLANT NAME
Snake Plant
LEAF COLOR (choose all that you can see)
SPOTS OR DISCOLORATION OF THE LEAVES
Yes
No
ARE THERE ANY INSECTS ON THE LEAVES?
Yes
No
HOW OFTEN DO YOU WATER YOUR PLANTS?
Daily
Every 2-3 days
Weekly
Less than one week
OVERALL PLANT HEALTH
Very unhealthy
Very healthy
Report
Test
Question 3
How would you try to cure this Monstera?
Give more water
Replace it into shade
Give less water
Plant it to a bigger pot
Test
Question 3
How would you try to cure this Monstera?
Give more water
Exactly! This plant is just thirsty...
Test
Question 3
How would you try to cure this Monstera?
Replace it into shade
This plant likes light, but you have to give it more water.
Journal
PLANT NAME
Snake Plant
DATE
17.10.2023
OVERALL PLANT HEALTH
Very unhealthy
Very healthy
LEAF COLOR (choose all that you can see)
YOUR PLANTCARE PERFORMANCE
Insufficient
Excellent
ANY OTHER NOTES
Submit