

# **Enhance Inclusion and Accessibility with User-Centered Design Practices**

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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## **Introduction**

Advancing technologies have endless possibilities for enhancing human life. However, new technology comes with new problems. Some of the consequences due to design deficiencies are hardly bearable. These insufficiencies in products could invoke stereotypes and biases and marginalize minorities. Beyond mere usability concerns, more serious societal implications also surface. Wayfinding, for example, is more than directional adherence and spatial navigation - it is an essential skill interconnected with independence, quality of life, mental health, and economic prosperity (Parker et al., 2021). However, not all affiliated groups are often involved enough during the development of a new technology. Therefore, the urgent need for a more user-centric and inclusive approach to design is demanded for a more inclusive society.

Considering the increasing technological involvement in daily life, societal feedback and opinions should be carefully evaluated and implemented in design practices. This analysis, including literature reviews and case studies, aims to further understand the interdependence between society and technology. Using the Social Construction of Technology (SCOT) framework, the research would consider both the social and cultural factors that influence technology development, highlighting the importance of incorporating user feedback into the process (Est & Brom, 2012).

## **Methods**

The question of "how user-centered designs could be optimized to ensure maximum DEI (diversity, equity, and inclusion) and accessibility" is analyzed through design methodology principles emphasizing user-centered mindset efficacy of the result deliverables (Phan, 2022). Initiating with a thorough exploration of existing literature on design principles, user-centered

design concepts, and cognitive ergonomics will provide base grounds for scoping the problem and addressing the prevailing design inadequacies.

Through a focused case study on an online learning platform, how different acting factors contribute to the overall product development process could be differentiated to understand user-centered design's importance better. This case study aimed to understand the user, identify current design deficiencies and provide insights into how different perspectives could be considered during the design phase. To achieve this goal, primary data are collected from relevant social groups, including the engineering team, marketing strategy team, and general user community via surveys. Users are self-volunteered and randomly selected to complete this survey regarding the usability of the selected product to ensure a comprehensive viewpoint. The results would include qualitative and quantitative data, which will then be synthesized to disclose design anomalies. The evaluation of application design is assessed through different perspectives to contribute to a comprehensive understanding of the subject matter.

## **Background**

### *The Design Process*

As technology advances, more inherited design deficiencies surface. These deficiencies could cause inconvenience to people in daily life; they could also cause severe consequences to people with special needs or any disabilities. In order to mitigate this, a more disciplined design methodology would be helpful to foster an overall process for design. The steps for such a process vary by different practitioners, but the fundamental steps are the same: 1) define an actionable problem and thoroughly assess the user demand behind the problem. The designer should select the smallest and simplest behavior that matters (Fogg, 2009), 2) systematically

analyze the existing problem and determine the critical preventive factor for such problem to be solved, 3) gather data from current users and analyze such data to understand user needs best, 4) prototyping and testing possible solutions, 5) iterate and test the persuasive solutions, this phase should be repeatedly carried out to ensure the most optimal solution is selected eventually, and 6) final refinement and launch of the solution (Phan, 2022).

### *User-Centered Mindset & Human Cognition Ergonomics*

The day-to-day design practices sometimes fail to consider situations that are unfamiliar to selves. Therefore, involving the user and prioritizing the actual user needs is essential throughout the design process. User-centered design, describing the design processes in which end-users influence how a design takes shape (Fogg, 2009), incorporates the user's input into the beginning of development and focuses on usability and accessibility. Few techniques are required to involve users in the development process, including interviews and questionnaires, on-site observations, simulations, critical evaluations, and tests such as usability testing and accessibility testing. By starting with one real person and one real problem, designers can ensure the product/deliverables are effective solutions targeting a specific audience.

Understanding human cognition and how the human brain functions behind the scenes is essential before any design starts. Such comprehension provides valuable perspectives to ensure the solution matches user expectations. Cognitive ergonomics is a discipline that works in harmony with the human mind instead of against it (Bergignat, 2023). This concept describes 1) how work affects the mind and 2) how the mind affects decisions (Hollnagel, 2010).

Understanding ergonomics could enhance usability and user experience by comprehending the

underlying logic behind human cognitive processes. This knowledge could increase user satisfaction and productivity by reducing cognitive strain and streamlining interactions.

### *SCOT Framework & How SCOT Links to User-centered Mindset*

The Social Construction of Technology (SCOT) is a theory that considers human factors in shaping technological advances and the mutual interdependence between society and technology development (Est & Brom, 2012), highlighting the importance of considering the user's needs, experiences, and contexts in the design process. The framework provides a way to analyze non-technical factors that influence technological innovation, understanding that technological change is as much a social process as a technical one.

### **Social Construction of Technology (SCOT) Framework**

The field of Science, Technology, and Society (STS) examines the interconnection between scientific, technological, and social worlds, focusing on how these domains influence and shape each other. Therefore, the integration of User-centered design (UCD) and the endeavor to optimize technological innovations to maximize DEI fit within the field of STS by highlighting that technology is not merely a product of engineering but a complex social artifact that reflects and affects societal perspectives.

Developed by Trevor Pinch and Wiebe Bijker in the early 1980s, the SCOT examined historical case studies to illustrate how social processes shape technological innovations. Within the studies of SCOT, several scholars have proposed their standings and concepts on this interdependent relationship. This framework challenged the technological determinism developed by Thorstein Veblen, which stated that product innovations were compromises

between social groups rather than internal technical logic (Smelser & Baltes). Bijker categorized a group of historians as the "internalists" because they focused more on technological details internal to innovation. In contrast, another group was referred to as the "contextualists" because they leaned more towards how users have adapted and shaped innovations for their purposes (Oudshoorn & Pinch, 2003).

Critical aspects of SCOT include interpretive technological flexibility, relevant social group identification, user demand prioritization, and final closure and stabilization. These aspects align perfectly with the UCD mindsets, which focus on iterative development, where user feedback is continuously considered to shape and improve the technology. It is essential to break into a more detailed assessment of UCD to foster a more usable and accessible environment for addressing broader societal implications of technological use.

Beyond technological design practices, the SCOT framework has expanded to other areas. Its adaptability makes it a valuable tool for comprehending diverse phenomena. For example, in the healthcare and medicine industry, SCOT has been implemented to understand how medical practices are adapted within different healthcare settings. By evaluating the different roles that social groups (including but not limited to healthcare providers, patients, and stakeholders) play during these practices, researchers could explore how these technologies are shaped and influenced by the end user and how they are more acceptable and accessible for people with special needs.

### **Discourse Analysis for Incorporating user-centered design principles**

As technology advances, more inherited design deficiencies surface. The interdependent relationship between society and technological advancement makes it essential for the design

process to be more user-centered, inclusive, and accessible to all. In order to ensure maximum DEI, defining design deficiencies with analysis incorporating different parties involved in the process should be conducted before any technological innovation. Examining the current applications of technology could limit the potential unintended consequences and optimize user experiences. Different perspectives from all relevant groups involved in the process should all be considered to ensure comprehensive understanding. Through a focused case study on an online learning application, such analyses aim to draw conclusions and guide future research.

### **Identify problems with flexibility in interpretation**

The first step in improving technology is locating an actionable problem and thoroughly assessing its conditions and logic (Fogg, 2009). The most complex aspect of technology evaluation is the flexibility of user interpretation. With diverse demands, context, and background of the user group, technology applications could be used and interpreted in various ways, which requires more thoughtful consideration throughout the product development process.

Various online learning tools have been developed over the past decades to better assist and fulfill the educational needs of the population. Duolingo, one of the most popular online platforms for language learning, provided an overall accessible environment for all populations to engage in education. Duolingo has achieved a leading role in the education industry by incorporating design choices like user-friendly interfaces, gamified learning experiences, and diversified learning activities. One of the flexibilities Duolingo has provided its users is its high customization and personalization with content and learning pace. The users could customize

their experience by selecting specific topics, adjusting the difficulty level, and setting their own pace (Fig.1).

Choose a daily XP goal that will help you stay motivated!

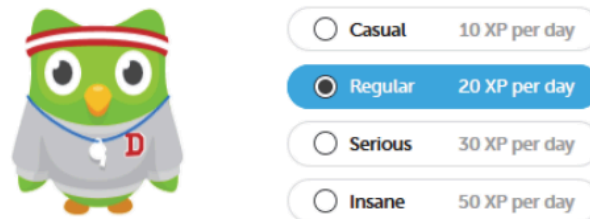


Fig.1 Personalizing one's learning goal in Duolingo<sup>1</sup>

This adaptability makes the aid suitable for learners with different needs and objectives.

Depending on the self-set goals and pace, the app would then send regular reminders to help the learners stay motivated in their learning journey. However, according to a survey conducted in 2016, around 52% of the learners either disagree that the self-set goal and regular reminders help them stay engaged in learning or stated that the strategy makes no difference either way, regardless of whether the rest of the learners consider the reminders as applicable (Falk & Götz, 2016). This survey result concluded that meeting diverse expectations requires more work despite the highly customizable option.

Meanwhile, Duolingo's learning contents in their course also received different opinions from the user. On the one hand, users perceived the gamified strategy positively for its effectiveness in creating a learning habit and keeping them engaged throughout the learning experience. In contrast, others reflected that the course design is suitable for pure memorization (Fig.2) but needs more general language structures and cultural contents, which are essential for

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<sup>1</sup> <https://www.duolingo.com/settings/coach>



successfully mastering a language (Ng, 2023). The problem ties back to the users' expectations for language learning. Some use it solely as a medium to extend their vocabulary, while others might demand more academic materials within cultural and daily life contexts.



Fig.2 Duolingo Course Contents

## Understand Usability and User Experiences

With the interdependent influences between society and technology, it is important to incorporate user input in all levels of technological development. As J.Karat and C.M.Karat noted in their study: "... this goal [usability] is achieved through the involvement of potential users...design is ultimately a partnership between developer and user..." (Karat & Karat, 2003). According to User-Centered Design (UCD) principles, the usability of a product should enable the user to easily navigate through things and find solutions throughout (Norman & Draper, 1986). One of the ways to directly gather user feedback regarding a product is through usability testing, which aims to observe users' behavior and answer survey questions to identify any usability problems and gather insights to improve the product's design and functionality.

In order to receive user feedback for Duolingo, a survey study was conducted<sup>2</sup>. The participants self-volunteered, and the survey was anonymous to ensure the authenticity of the result. The questionnaire has questions about users' preferences on specific features, experience, usability of navigating the application, opinions regarding UI choices, and general personal background information. The result matches the interpretive flexibility with diverse opinions and perspectives regarding this learning experience. On a scale of 0 to 10, 70% of the participants indicated familiarity with primary navigation, but only 42% responded that they had five or higher ease of use.

Similar usability tests conducted under different interests of researchers yielded more significant results from the increased number of test subjects. A study by Tomomi Matsuzaki from the University of Washington carefully assessed the usability of "learning a new writing system" tools over ten weeks. The above survey and flexibility analysis findings gained a high degree of similarity. Although the gamified course setup enhanced the user's satisfaction during the learning process, the complexity of navigation and the lack of instruction increased the mental load for the user. Specifically, the study result stated: "While they were able to learn it quickly, it was not an intuitive and pleasant experience." This gamification design choice, therefore, interfered with general learnability and caused users to have different opinions on the mode of instruction(Matsuzaki, 2022).

By conducting usability tests, valuable insights from the target population could be gained to investigate users' interaction with the given product, what they think is the most important, and where they face challenges. Feedback is crucial for the iterative design and development process, which could help the product remain user-friendly and effective in

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<sup>2</sup> A list of sampled survey questions is included in Appendix A. The survey was revised to better fit the specific application being researched.

achieving its ultimate goals. The diversified user population requires such thorough analysis to ensure a comprehensive appreciation of the underlying problem.

### **Incorporate Business Considerations**

The designs of any technology should be iterative based on feedback from its social groups. Incorporating user experience allows technology to evolve and maintain relevance in the competitive technological market. Regardless of the one end of the process - the user group - the other ends should also be considered - the product's business teams<sup>3</sup>. The product would not sell independently, therefore marketing and advertising are crucial for its success. Depending on the application's values, the marketing strategy might not be the most favorable way for the user. However, it was developed thoughtfully and reflected the product's target market.

The target group of Duolingo is learners who want to learn a new language but demand to remain financially stable. The marketing strategy reflected this aim, focusing on building a solid product while increasing its user base and retention rate (Brand Vision, 2024). In a tech-savvy society like today, one of the best ways to reach a broad audience is through social media. By actively communicating with users via media like email reminders, app notifications, and iPhone widgets, Duolingo uses its mascot and cartoonish avatars ("Duo" and avatars, Fig.3) to engage users and increase (at least in theory) the retention rate for a user to stay on the application.

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<sup>3</sup> Even though there are various aspects incorporated into the business development cycle, the scope of this research project only concerned one of these teams (the marketing aspect).



Fig.3 Duolingo's "Duo" and avatars

Carefully evaluated by the Duolingo marketing team and the engineering team, Duolingo decided to send daily practice reminders to keep the learners on track and return to the application routinely. The messages are personalized based on the user's learning habits, selected language modules, and the current study streak (Yancey & Settles, 2020). The messages are updated rapidly to eliminate the dullness of repetitive reminders. Introducing the bandit algorithm, a form of AI where an algorithm repeatedly chooses between the same set of options and gradually learns from past user decisions to determine the most appropriate option to send to the user (Yancey & Settles, 2020), Duolingo makes sure the message templates best motivates the user to complete a learning lesson after receiving the reminder.

The most frequently used media for such reminders includes emails, push notifications, and newly added iPhone widgets (Fig.4). Even though the vision for these notifications is to help new learners return to the lessons and develop good study habits, the actual user perceptions state otherwise. Some perceived the messages as "passive-aggressive" and chose to disregard them because the messages "legitimately made me [the user] feel kind of bad like I was lazy and unable to keep up with my goals." (Lashbrook, 2020) Though not perceived positively, the marketing tactic here is guilt appeal, which seeks to arouse negative feelings, and the desired

response would be perceived as likely to assuage (Oxford Reference, 2024) - in this case, return to the application and complete a learning lesson. Based on a study conducted by Angela Lashbrook, a writer based in Puerto Rico, stated that "they [Duolingo's reminders] are really annoying and don't serve their purpose... The manipulation makes it feel like work. It's so fun when I do open it up, but the notifications don't make me want to." (Lashbrook, 2020). Therefore, it could be concluded that while guilt can be practical in other occasions, like charities, making people feel guilty about a paid product or service could be less effective.

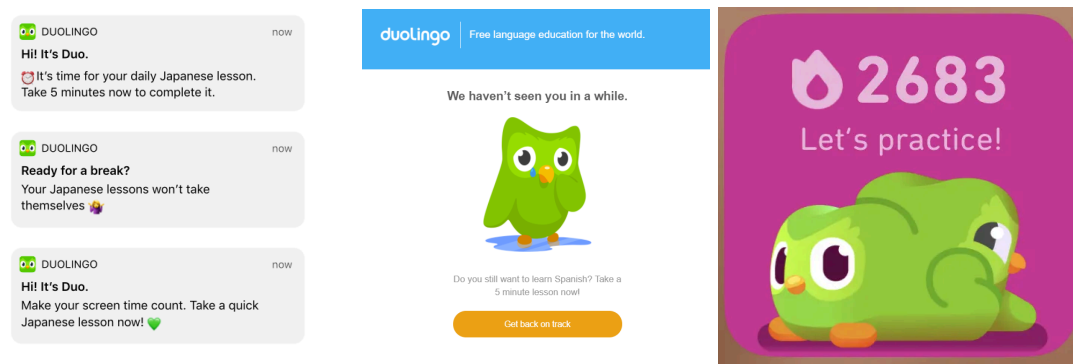


Fig.4 Duolingo reminders (push notifications, email, iPhone widgets, respectively)

Although the business team is satisfied with this marketing strategy and the technical team indeed presented a well-developed algorithm to successfully launch such a feature, the negative user feedback made it clear that a better strategy needs to be implemented. Acquiring such user input would allow the product to satisfy user demands better while remaining effective in business success.

### **Achieve Technology Closure and Stabilization**

If all ends of the development process continue to contribute and incorporate each other's perspectives by prioritizing the primary function and value of the product, a stabilization of the design and use will eventually be achieved. The flexibility of the product's meaning would

diminish over time as the involved social groups reach a consensus about how this technology should be used and understood. The common perception of such product elements might dominate and guide future iterations and features, achieving a form of technological closure.

Back to its root, the core function of Duolingo is language learning, with an initiative to create an inclusive and universally accessible environment. Regardless of the delivery method and diverse expectations from all affiliated groups, the consensus function of learning is the underlying drive that supports the product's success. From the user's perspective, the application should enable an engaging learning environment for new subjects while preserving a lower-stake learning experience compared to the traditional classroom setting. From a business perspective, the application should be practical and accessible for users while staying profitable to survive in the market (Panchaud, 2021). Despite the mixed reviews from the users, one temporary closure for achieving satisfaction from the above two perspectives is the gamified approach. By making the courses seem like games or adventures, the users are engaged with a relaxing learning experience, and retention also allows the application to stay profitable.

Regardless of the numerous benefits brought by the gamification strategy, there are some downsides to this strategy, resulting in ineffectiveness in the language acquisition process. As mentioned in the flexibility section and a UX case study by Florencia Daniele, some perceived the application as solely a memorization tool that lacks cultural and real-life content, making it hard to apply the knowledge in daily life. Other criticism includes poorly designed courses with truncated and intermittent learning flow (Daniele, 2023). Incorporating this feedback, Duolingo could iterate and include more varied exercise types and adaptive learning algorithms to cater to broader learning demands. For example, features like live communication between users with a similar level of familiarity could promote confidence in language verbalization and usability in

daily life, and the addition of culturally specific pictures and stories could further the understanding of the language content. This adaptability would help Duolingo move toward closure, where its pedagogical approach is accepted and satisfied with diverse user demands.

The application has already received some level of stabilization in the market by itself. First, it has already solidified its position as a leading language-learning app in the education market. By consistently aligning expanding decisions with user expectations, Duolingo could stabilize its role in the educational technology industry with high distinction from the rest of the market. On the other hand, the features and design style of the application have also reached a certain level of stability. There will be fewer, if not none, significant interface changes or changes in instruction methods as the platform matures. However, the technological stabilization does not mean the innovative iteration to be paused within the business, but rather that the fundamental aspects of the platform have become standardized.

The process of designating closure and stabilization has significant implications for the success of any product. It means that the product has navigated the initial uncertainties and varied interpretations of its purpose and value to achieve a more defined and stable situation. Stability allows products to focus on refining their features according to market demand without altering their core identity. Defining closure and stability also allows us to understand how artifacts influence other innovations within more extensive social, economic, political, and cultural processes (Humphreys, 2006).

### **Limitations and Future Research**

One of the significant limitations of the specific case study is the potential lack of representativeness of the participants. Particularly for the usability testing, even though the

analysis and case studies aimed to include a wide range of populations, the ultimate participants were learners with at least some experience with the application. Inclusion for people without experience with Duolingo might widen the perception of application interfaces and navigational systems without personal judgments distilled from prior knowledge. Nevertheless, while efforts were made to include a diverse group of users, it is still challenging to fully capture the entire Duolingo global user base that varies in age, language proficiency, cultural background, and learning styles. Specifically, the survey showed a lack of diversity in the participants' age (Fig.5). This limitation could potentially influence the generalizability of the result findings. Moreover, the controlled environments and assumed conditions in which the usability testing is conducted may not accurately represent real-world scenarios, which could skew the data on user behavior and experiences.

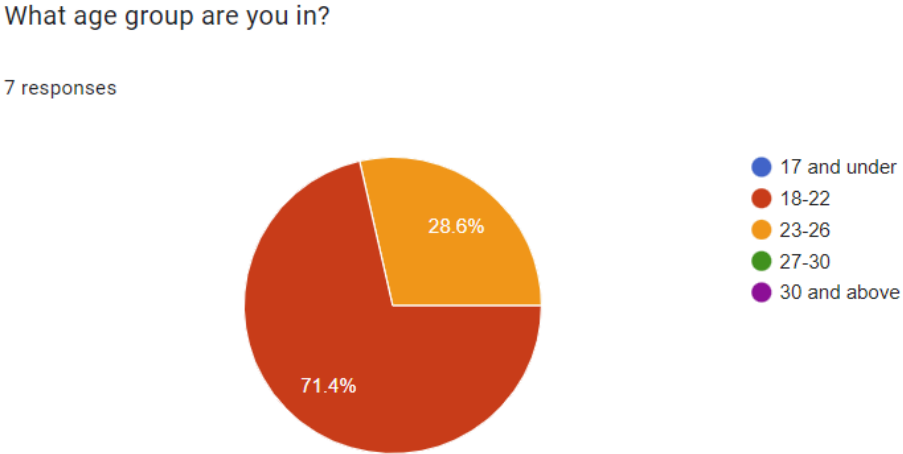


Fig.5 Age distribution from the survey conducted

Future research should address such representativeness limitations by incorporating a more extensive and diverse sample of participants, potentially through more unmoderated usability testing. This way, studies could capture a more accurate reflection of the general



population in their natural learning environment. Additionally, longitudinal studies could provide more comprehensive insights into how user experience evolves over time and how it influences the development of learning habits. Long-term engagement and user retention could better aid the product's development toward stabilization and success.

## **Conclusion**

In conclusion, examining Duolingo through the lens of the Social Construction of Technology (SCOT) framework offers a brief understanding of how user interactions and social dynamics could shape technological development and success. Actionable problems and undertakings should be defined, and analysis of involved parties should be conducted prior to any development process. Duolingo's iterations highlighted the importance of user input and the interdependent relationship between technology and groups that interact with it. Incorporating user feedback into the design process is not just about improving usability or user satisfaction; it also ensures that the product, in general, is inclusive and accessible to a diverse audience. The product can capture and satisfy user needs and preferences by aligning with user-centered design principles. By actively seeking and incorporating feedback from all affiliated groups during the development cycle, future products could better support diversity, equity, and inclusion (DEI) and serve a broader audience, which will help to create a more equitable digital landscape in the technology industry. Maximizing DEI in product development ensures that technology innovations do not reinforce existing inequalities but work to bridge gaps. As demonstrated by the case study, this approach benefits users and contributes to the technology's success in a rapidly evolving world.

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## **Appendix A: Survey questions for gathering user feedback**

Note: the participants were randomly selected from both student groups and general population, the website/technology/interface tasked to assess were uniformed and were being used (constantly or in the past) by the participants.

### *Personal Information & Demographic related:*

1. What age group are you in?
2. What categories do you best belong to? (student, teacher, employed, etc.)

### *Background related:*

1. How often do you use the website/technology/interface?
2. Which features do you use the most?
3. Which features do you use the least?
4. Which features do you like the best?
5. Which features do you dislike the most?
6. On a scale of 10, how experienced are you in using this?
7. On a scale of 10, how comfortable are you in using this?
8. On a scale of 10, how visually appealing is this to you?
9. What device do you normally use this on?
10. Are you aware of other competitor designs existing that serve similar functionalities?
  - a. If so, why did you choose to use this one specifically?
  - b. If not, what are some competitive advantages that this product has that keeps others from entering the market?
11. What are some suggestions that you have toward this product?