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# By-Design: Ethical Safeguards and Behavioral Psychology Competencies, A Survey of Undergraduate Engineering Majors

**Dr. Eman Hammad, Texas A&M University**

”Dr. Hammad is a cybersecurity expert specializing in large-scale network, critical infrastructures and complex systems. Her research focuses on leveraging in-depth knowledge of the systems to improve cyber resilience by-design. Dr. Hammad received her PhD in Electrical and Computer Engineering from the University of Toronto and has gained a considerable industrial experience working for one of the big technical consulting companies. She is currently the director of the iSTAR lab (innovations in Systems Trust and Resilience) at Texas A&M University. Dr. Hammad is the co-chair of the IEEE Future Networks Security Working Group, and is the Co-Chair for the IEEE P1950.1 Standard for Communications Architectural Functional Framework for Smart Cities. Dr. Hammad has over 70 publications and is a recognized expert in the domain of cyber-physical systems’ security and resilience, and security-by-design. Dr. Hammad is an IEEE Senior member and has delivered numerous keynotes and invited talks on engineering resilience and security by design for critical infrastructures. She is the recipient of the best-paper award, best poster award, and junior faculty award. ”

**Celeste Arden Riley, Texas A&M University - Kingsville**

Dr. Celeste Riley is an Assistant Professor of Practice in the Department of Psychology and Sociology at Texas A&M University-Kingsville, RELLIS Campus. She earned her bachelor’s degree in Psychology and Biology from Southwestern University and her doctorate in Clinical Health Psychology/Behavioral Medicine from the University of North Texas. Her research explores interdisciplinary curriculum development in collaboration with STEM fields such as computer science, health science, and engineering.

**Virginia Pederson**
**Pierre Atieh**

# By-Design: Ethical Safeguards and Behavioral Psychology Competencies, A Survey of Undergraduate Engineering Majors

**Abstract**

As evident from several products recently analyzed in research and legal hearings, ethical considerations of products' influence on user behavior, choice, and well-being may be eclipsed in favor of business outcomes. Persuasive design, a unidirectional process through mobile apps and other digital-enabled products, may translate to consumer risk or inadvertent outcomes. In this study, we examine utilization of ethical safeguards and psychological competencies in undergraduate engineering capstone courses, to inform innovative product design with student consideration of user well-being. To this end, we propose a research collaboration between engineering technology and psychology to promote undergraduate understanding and incorporation of ethical and psychological competencies that promote a balanced view of consumer persuasion, engagement, outcomes, and wellness. Our proposed curriculum and assessment model integrates practical guidelines for ethical product development with the ultimate goal of giving capstone students a framework for understanding product design as a foundation for consumer choice architecture.

This study introduces students to eight ethical and psychological constructs: privacy, informed consent, unintended outcomes and safeguards, participatory design, choice architecture, user motivation and engagement, measurement of user outcomes, and AI/ML. In the study, we extend previous work by the authors and aim to 1) develop and pilot the application of curricular integration of behavioral psychology, ethics and the broader engineering sciences, 2) improve and test the study's pre-post intervention surveys and the educational module in a larger and more diverse capstone student sample, 3) assess whether students applied proposed constructs, and 4) explore which challenges prevented construct application to capstone product design.

**Introduction**

The tech industry ranks as one of the fastest growing industries today [1], swelling with a great number of engineering professionals devoted to producing mobile applications and cutting-edge technology on which consumers rely routinely. Even as other industries slow post-pandemic hiring, robust hiring in certain technology factions continues [2], and relates to a surge in academic pursuits related to computer engineering and software development. Considering that 6.3 billion smartphone users worldwide spend much of their time on apps, it is no wonder that engineering technology/software engineering has become an attractive area of study [3]. Many of these products aim to support user well-being, offering support for healthier lifestyles, connection to meaningful relationships and resources, an array of entertainment options, mobility assistance that enhances independence, and information that shapes our life choices. In today's intensely competitive technologies market, developers are motivated not only by innovative passion and quality of life enhancement, but also by financial incentives to engage and retain users. The prospect of profit serves as a catalyst for tech industry growth, prompting us to pause and reflect on not just "what" products are being developed, but also "why" and "how" they are being created, as well as considering "who" is using those products.

Undergraduate coursework offers an ideal setting in which to incorporate ethical and psychological principles into engineering training. Traditionally, academic programs have offered diverse classes and training methods with focus on requisite technical and procedural skills for innovation. There are varying treatments of how ethical and psychological concepts

are integrated in engineering and computer science programs where technology products are built as part of such programs. While some programs may offer a course dedicated to the topic of ethics other programs integrate ethics as modules in different courses. The Accreditation Board for Engineering and Technology (ABET) includes consideration of ethics, public health and societal impact in its list of student learning outcomes [4]. More recently, calls to develop applied ethics learning outcomes have discussed both challenges and means of effective curricular integration [5] [6]. Forerunners of curricular change have proposed instructional collaboration between engineering and philosophy, resulting in the innovative "Embedded EthiCS" program within Harvard's computer science curriculum [7]. More recent works have examined this integrated approach through instruction-based methods such as ethical cases studies, quizzes and discussions [8] [9]. Other studies examined practical approaches such as interactive development environments, where students are nudged with automated better architecture choices while working on software development [10]. Finally, the psychological element of empathy as a design factor in senior capstone design projects has been evaluated through engaging students in the design of products for handicapped users [11].

Our variation of this integrated disciplinary approach combines ethical considerations with behavioral and motivational ones. Thus, we advocate for a collaborative research initiative between applied engineering and psychology. Our overarching objective is to respond to the escalating need to equip students with proactive educational approaches that foster balance among multiple factors including product engagement, utility, developer success, and stakeholder well-being. Additional aims for this work include: (i) deploying and piloting a student survey that determines which ethical and psychological constructs are viewed as most relevant to capstone projects (ii) assessing student perception of optimized timing to implement these constructs during product development, and (iii) identifying salient challenges to student incorporation of ethical and psychological principles into product design [12].

In previous work by the investigators, an initial framework was developed to explore the integration of psychological and ethical principles in a computer science program curriculum and the process of app design in an undergraduate capstone design course. This involved delivering a brief educational "intervention" to computer science capstone students, introducing psychological and ethical principles relevant to technology products. Main findings of the initial study highlighted the need to expand and improve the study instruments, in addition to expanding the surveyed student population [13].

In this study, we aim to refine proposed curricular integration of ethical and psychological guidelines with the broader engineering sciences. To achieve this objective, we 1) revise the study protocol where we a) expand the survey instrument to include additional constructs pertaining to the current technology landscape (i.e. we added AI/ML), b) clarify the survey instrument language, and c) revise the educational intervention to include example recommended and discouraged practices. 2) pilot the study with the revised instrument with a larger student population in a different engineering subdiscipline , and 3) explore perceived challenges to application of ethical and psychological constructs. We propose eight (8) psychological and/or ethical constructs as relevant to product design, with each construct relating to a disciplinary framework.

## Background and Proposed Framework

To facilitate this study, a framework is developed based on the relevant multidisciplinary areas, as discussed in the introduction. This framework is depicted in Figure (1), which shows three general categories to capture the different constructs included in the study. It is worth noting that there is a level of complexity in the interrelations between the different categories and the constructs. The AI/ML related topics/questions were shown in their own category due to the increasing criticality of ethical and psychological guidelines with respect to products leveraging AI/ML.

To facilitate this study, a framework is developed based on the relevant multidisciplinary areas, as discussed in the introduction. This framework is depicted in Figure (1), which shows three general categories to capture the different constructs included in the study. The combination of ethical and psychological categories highlights the interconnectedness of moral responsibility and user-centric design in product development. Ethical principles ensure that products are developed with fairness, privacy, and societal well-being in mind, while psychological insights focus on understanding user behavior, motivations, and emotional responses. This conjunction provides a clearer pathway for integrating ethical awareness with behavioral insights, enabling students and practitioners to critically evaluate both their own intentions for innovation and factors influencing how humans engage with technology. . As ethical concerns in AI/ML continue to grow, this integrated approach ensures that emerging technologies align with human-centered values, fostering a more conscientious generation of engineers and developers. The placement of AI/ML as a third, higher-order factor indicates our prediction that there may be unique ethical and psychological factors to consider for designs capitalizing on this technology.

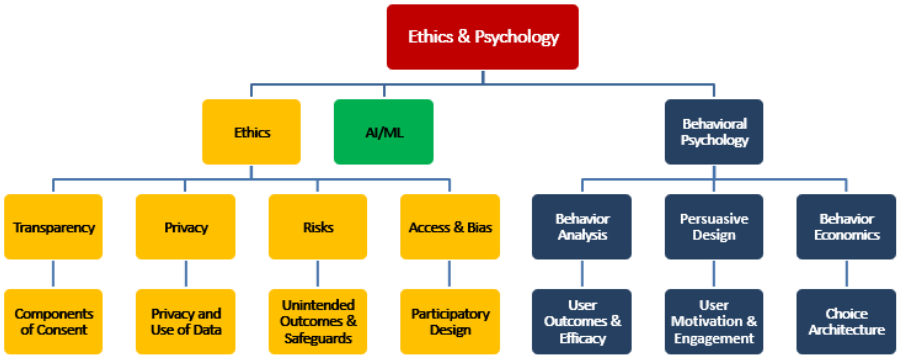


Figure 1. The proposed ethics and psychology framework showing relationship of ethical and psychological principles to the survey design

**Ethics Related Constructs**

In modern society, engineering products touch nearly all aspects of human functioning, including medical treatments, transportation, information consumption and dissemination, and the environments in which we live, work, eat and play. This comprehensive influence, in addition to design impact on societal infrastructure, has long been guided by the imperative of safety and best efforts toward ethical design. Ethics is the interdisciplinary field encouraging product design that factors in user and stakeholder well-being, balancing these aims with developer interests.

Digitization of engineered products requires a focus on ethical dilemmas that arise from data transmission, extending traditional notions of design safety. Previous approaches to system design and development, such as the structured systems analysis and design method (SSADM), focus more on technical issues than on human issues [14]. Ethical dilemmas related to digitized products arise in connection with data usage and privacy, informed consent, and researching possible unintended outcomes and safeguards. The digital environment cannot be protected without knowing a product's vulnerabilities relative to its benefits, conditions that increase risk, and populations most at risk of unintended harm. Further, user autonomy in decision-making must be respected, while also creating innovative products that are profitable to developers. Dhirani et al. meticulously catalogue numerous ethical dimensions that are relevant across emerging technologies such as AI/ML [12]. Though worded differently than our constructs, their suggested ethical principles for guiding development of AI/ML contain semantic overlaps with our framework. We relate their proposed ethical principles (transparency, respect for human values, fairness, safety, accountability, and privacy) with our framework as outlined below:

(1) **Transparency** supports informed consent and user autonomy to make decisions about product usage that are based on a thorough understanding of risks and benefits. This principle underlies our construct, "Components of Consent."

(2) **Respect** for human values and differences promotes sensitivity for cultural diversity and beliefs, and compassion for populations who may carry higher risks of adverse impacts from products. Our suggested construct, "Participatory Design," addresses the likelihood that final products will be respectful of diverse constituencies.

(3) **Fairness** needs to be ensured without discrimination, and with avoidance of predatory or opportunistic data collection. "Participatory Design", "Choice Architecture", and "User Motivation" and Engagement" are offered as ethical and psychological constructs that promote fairness and user well-being.

(4) **Safety** refers to the general well-being of users and requires proactive research on unintended consequences or possible adverse impacts on either users or society at large. Our construct, "Unintended Outcomes," also promotes proactive design strategies to minimize risk of harm to users and other stakeholders.

(5) Accountability may be incorporated in design in various ways, including measurable outcomes for product aim, and audit mechanisms for processes largely "unseen" by the user (e.g. AI decision rules).

(6)) **Privacy** guarantees means that safeguards must be implemented to prevent the disclosure of sensitive information [15]. Our construct," Privacy and Use of Data" echoes this call for careful data management.

### A. Privacy and Use of Data

In today's digital environment, mobile devices dominate screen time. According to Comscore, "79% of total digital minutes in the U.S, were spent on mobile in August 2020, up from 78% in August 2019 [16]. During this interaction, valuable data is collected from users. Further, consumers spend additional time interacting with other technologies such as IoT devices (health wearables, household technologies, etc) that may handle and collect private and potentially sensitive data. This information serves various intended purposes. However, its existence also enables data breaches unintended by solution developers. Transparency regarding how this data is being handled is crucial. Users should be fully informed about what kinds of information is being collected, how it will be used and where it will be stored. Privacy laws exist to ensure that corporate data collectors maintain transparency, allowing users the autonomy to opt out at any time, as well as access their data upon request. Some data that is collected is particularly sensitive in nature, and needs to be properly identified and then treated with extra caution. To protect sensitive data, product developers/engineers must "define and design for privacy [17]. Implementing robust safeguards promotes responsible data handling and fosters vital user trust in the digital world. Students have a moral obligation to follow the same guidelines as corporate data collectors to ensure ethical productivity. It is critical that students be taught the importance of responsibly collecting and protecting user data. Data management and technology innovation should be tightly associated concepts and skills.

### B. Components of Consent

Obtaining user consent is a necessary ethical practice, ensuring that users are made fully aware of and agree to the use, collection and possible sharing of their personal data. A consent document, or user agreement, serves several important purposes: transparency, legal compliance and user understanding. Honesty and clarity should be prioritized by developers; they should present information free of jargon and written in straightforward, understandable language. Users should hold the power to decide freely about how their data is used. By providing settings that are easy to navigate for privacy preferences and clear options for consent, user autonomy is respected. Problems arise when consent documents are extremely lengthy, full of unfamiliar legal terminology and difficult to understand. Often, critical information is embedded within the legal document and goes unseen by the user. Therein lies the importance of getting ahead of this already present problem by incorporating education during undergraduate studies about how to ethically create and provide components of consent into future product developments. It is important to note that consent may extend beyond the elements of data to include proper product usage, liability related clauses, and others.

### C. Unintended Outcomes

Unintended outcomes refer to the unexpected consequences that surface after the deployment of digital technologies. These outcomes, whether positive or negative, can have an impact on end-users of the technology. For example, a product originally designed for recreational purposes might have the positive outcome of improving cognitive skills. While this example reflects a positive outcome, negative consequences occur more frequently. An application using biased algorithms might discriminate against certain groups. If this goes unnoticed, an unintended outcome can inadvertently harm users or even perpetuate biases. An application designed primarily for user engagement might lead to excessive usage and addiction. Social media Apps and digital games fall into this category. Recognizing the potential for unintended outcomes in product development is crucial for several reasons. User experience and user trust can be significantly impacted By unexpected behaviors, crashes, or data leaks. Anticipating unintended consequences during product development is a critical step in mitigating harm and maintaining a positive user experience. While post-hoc regulation is essential, anticipating potential harm before deployment would be a more effective strategy. Identification and troubleshooting negative impacts of product use are skills that may be explicitly incorporated in undergraduate curriculum. By recognizing these possible consequences, product developers and engineers can take the time to make ethical choices and prioritize user well-being.

### D. Participatory Design

While product design requires innovative ideas and technical expertise of developers/engineers, optimized creation requires input from users and other stakeholders. Without considering insight from end-users, designs may fall flat or short of intended goals. Participatory design engages key stakeholders as full and equal participants throughout the product design process [18]. Participatory design ensures that the final product aligns with the actual needs and preferences of the users. By involving users from inception, designers/engineers create solutions that truly address real world challenges. Another benefit of participatory design is that by involving a variety of stakeholders early in the development process, developers are able to identify prospective issues. This prevents potentially expensive redesigns and reduces the risk of creating a product that doesn't meet user expectations. Additionally, participatory design is a good way to ensure that ethical considerations are addressed before and after launch. By actively participating in the design process, users are encouraged to provide valuable feedback on potential ethical dilemmas. Involving a diverse user group throughout product development through participatory design can empower users by giving them a voice in the creation of a product. Trust is formed between the developers and users that increases as decisions are made collectively [18]. Social inclusivity and accessibility are promoted by involving a wide range of users in the design process, resulting in products that reach a wider range of people. Last, participatory design promotes a sense of ownership among the technology users. Microsoft has already adopted the use of participatory design in their development process [19][8]. From conception to deployment, users were given the opportunity to give their opinion on products as they were being developed. With larger corporations taking action by incorporating participatory and inclusive design, it gives emphasis to the importance of teaching these skills early. By integrating modules about participatory design into undergraduate course work, we can provide future product developers/engineers with the tools to create a more ethically sound product.

## Behavioral Psychology Constructs

Broadly, behavior analysis is the sub-discipline of psychology that focuses on using learning principles, particularly operant conditioning, to understand and motivate human behavior [20]. Researchers and practitioners in this area seek understanding of the functional relationships between specific, observable behaviors and their antecedents and consequences [20]. The principles of this field underlie persuasive design, which developers may utilize to motivate and alter user behavior, and intersect with ethical considerations, as developers may motivate users to do things that are not in their own best interest. Design features that drastically increase drive user engagement, without regard to or understanding of the potential for problematic overuse, would be an example of persuasive design that motivates and alters behavior but without due concern for the user's well-being.

Fogg's Behavior Model summarizes components and complexities of behavior change relevant to persuasive design [21]. He emphasizes that behavior change requires understanding of motivation, a person's capacity to perform the target behavior, and an antecedent or trigger to perform the behavior [21]. Missing nuances of these three behavioral components and their interactions may cause the persuasive design misses or unintended problems. Conversely, an informed and effective assessment of human behavior change factors requires interdisciplinary collaboration and may help developers maximize benefit while minimizing design pitfalls.

Toward this end, behavioral economics combines elements of economics and behavioral psychology to understand how emotions influence human decision-making in predictable ways, or the ways in which we are "predictably irrational," [22]. Persuasive design aims to change user decisions through "choice architecture," or the context and means by which choices are presented. Choice architecture exists whether one is shopping in a grocery store, looking for specific dinner ingredients, or downloading and orienting to a new app. The manner in which options are presented to consumers act as behavioral antecedents and may "nudge" them toward a sample, purchase, or upgrade. A "nudge" implies choice architecture that influences people's behavior in a predictable way without forbidding any option, significantly changing economic incentives, or curtailing user autonomy [23]. The purpose of nudges is not to force change, but to persuade or reinforce adoption of new behaviors. By ethically deploying nudges in product design, designers (viewed as choice architects) can improve lives and help solve many of society's major problems while also enabling freedom to choose [22]. The purpose of nudges is not to force change, but to persuade or reinforce adoption of new behaviors. By ethically deploying nudges in product design, designers (viewed as choice architects) can improve lives and help solve many of society's major problems while also enabling freedom to choose [22].

### A. Choice Architecture

Developers must decide how, when and where to present user options in products. Choice architecture refers to how user options are presented and perceived. Choice architects may alter

how choices are presented without significantly altering incentives or the information that people are given about each option [24]. The focus of choice architecture is on structuring the choice environment to guide users toward a specific outcome. Defaults, choice placement, categorization, visuals, and framing are all tools utilized by the choice architect to influence user decision making [25]. Armed with this knowledge, students have means of presenting choices in a way that "nudges" consumer behavior, while respecting user autonomy and optimizing well-being.

### B. User Motivation and Engagement

User motivation and engagement plays a pivotal role in successful product development. Having a clear understanding of how motivation is defined is essential. As a product developer, you should ask yourself "why are users "using" or interacting with this product?". "Is it for productivity, wellbeing, social connection, or entertainment". Motivation driven by internal factors like curiosity or enjoyment (intrinsic motivation) and motivation pushed by external rewards such as discounts or points (extrinsic motivation) influence the behavior of a user. It is the responsibility of the product developer to align the motivation with the features of the product to create a safe and engaging experience. An engaged user is both loyal and active, and chances are that they will use the product on a consistent basis. Product developers use a number of strategies to enhance user engagement including user interface (UI) strategies, personalization, notifications, social features and gamification [26]. Undergraduate students studying product development should learn how to utilize these strategies in a way that increases motivation and engagement without the use of manipulative tactics that ignore user well-being.

### C. Measurements of Outcomes and Efficacy

Measuring a product's effectiveness is essential when developing a product. Measurements of outcomes and efficacy refer to assessing the impact, effectiveness and success of a product. A user should be provided with a way to rate their experience and share both positive and negative feedback. From the developer's standpoint, a valid measurement tool should be utilized to measure a well-defined outcome. This tool must measure not only the intended use but also align with the product's stated objectives. Recent research on the efficacy of mental health apps provides a clear example of the importance of measuring outcomes and efficacy. Apple and Google's app stores offer roughly 20,000 mental health apps that offer self-help tools focusing on things such as stress management and relaxation [27]. However, research suggests that the majority of these products lack the empirical research to back their efficacy [28]. These shortcomings can lead to significant consequences and result in severe harm to potential users. Including education on the significance and appropriate methods of measuring outcomes and efficacy, we can help to prevent the release of products that could be harmful to end users.

### Artificial Intelligence/ Machine Learning

As AI continues to evolve, product developers are confronted with a dual challenge: controlling its transformative potential while ensuring its application aligns with ethical

standards. Responsible AI materializes as a framework constructed to meet this challenge by hilighting ethical considerations such as transparency, privacy, risk management, and fairness [29]. This concept encourages the creation of AI systems that not only excel in technical performance but also align with societal values and user needs. Extracting insights from recent research, the implementation of Responsible AI principles involves both technical and human-centered approaches to achieve accountability and inclusivity in product design.

Responsible AI integrates core principles such as transparency, privacy, risk management, and inclusivity to ensure ethical and effective AI systems. Transparency promotes trust through clear documentation of AI mechanisms, allowing stakeholders to comprehend system capabilities [30]. Protecting privacy involves embedding safeguards for sensitive data and maintaining vigorous data handling practices to thwart misuse [31]. Risk management proactively identifies potential failures through comprehensive analyses and involves stakeholders to mitigate harms and biases. Inclusivity is fostered, potentially via participatory design, by integrating human values into design processes, with collaborative beta programs ensuring systems fairly serve diverse users. Together, these principles establish a foundation for AI that aligns with societal values and ethical standards.

Behavioral psychology enhances the Responsible AI framework by clarifying how users interact with AI-driven products. Insights from psychological principles can inform design strategies that prioritize user well-being. For instance, developers can incorporate features that guide users toward informed decision-making, allowing for autonomous decision making and fostering positive user experiences. Consequently, Responsible AI represents a holistic approach to AI development that incorporates ethical safeguards, stakeholder collaboration, and behavioral psychology insights. This underscores the need for interdisciplinary collaboration and constant evaluation to guarantee that AI technologies align with the ethical standards and expectations of their users.

**Method**

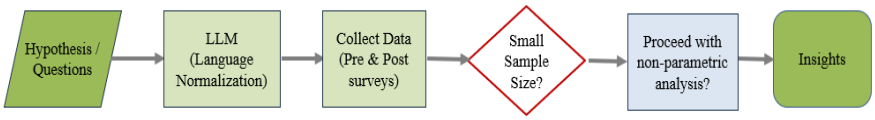


Figure 2. General approach

Figure (2) depicts the general approach that we followed in this study. The hypothesis questions detailed in the introductions are used to design the study protocol and the survey instruments which will be detailed later in this section. This was followed by a language normalization step where LLM (Perplexity and ChatGPT) models were used to help simplify the survey questions to avoid complicated discipline specific jargon [32]. The LLM models were prompted to rephrase the given question for target reader of an 8th grader. This level was selected based on recommendations that 85% of a general audience understand information at an eighth grade reading level [32].

The revised version was later edited by the research team to ensure alignment and consistency with the involved disciplines (engineering, psychology) and the question intent. The study protocol is followed to administer the surveys to the target student population and to collect that data. Depending on the sample size, the proper analysis tools are used to gain insights.

### A. Study Protocol

The IRB approved study protocol is shown in Figure (3), with two surveys: a pre-intervention survey (Form A), and a post-intervention (Form B) survey. The intervention is a short presentation recording that must be completed by students participating in the study after responding to the pre-survey and before filling out the post-survey. Participating students are offered extra credit as a participation incentive. The intervention is designed to provide a clear outline of each of the constructs supported by practical "what to do" guidance to help nudge the student to relating the intervention to their own capstone projects.

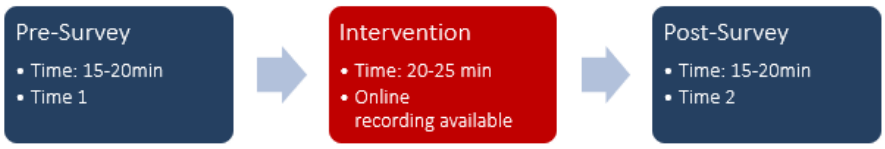


Figure 3. Study protocol illustrating the pre-survey, intervention, and post-survey that are delivered to participating students through the campus LMS

Participating instructors were provided with all recruiting and research materials in order to load both surveys and the instructional video into their course learning management system (Canvas). Following recruitment, course instructors provided asynchronous access to the pre-intervention version (Form A) of the survey. Within one week, participants were provided asynchronous access to the intervention video/PowerPoint. Viewing was required before students could access the post-intervention survey (From B). We then coordinated course instructors to obtain anonymized survey responses. Respondents received the surveys and intervention during the Fall 2024 of their two-semester capstone Project, on weeks 14 & 15 of a 16-week semester. Therefore, their responses capture a retrospective review of their product development process.

### B. Participants & Course Structure and Curriculum

Senior students enrolled in capstone design courses (e.g. ESET 419, ESET 420) were recruited through their capstone course instructors using two main communication methods: 1) an LMS announcement that is shared through their course instructor, and a 1-slide power point summary of the study detailing expected time and overhead on the participating students. During the recruitment process, students were offered extra credit for their participation in our study, or one of two alternate assignments that were not used for research purposes but prompted additional

thought about ethical design. Inclusion criteria included being 18 years of age or older, capstone enrollment, self-selection for participation, and completion of an online informed consent form.

### C. Instrument Design

The "Survey of Ethical and Psychological Principles for Engineering and Computer Science students," was based upon our earlier instrument [13] , which incorporated seven psychological and ethical constructs. The initial survey was further modified to a) include more descriptive information about student participants, b) clarify the language of the questions, c) explore reasons why students may not incorporate these principles into product design and d) add questions relevant to AI/ML specific issues, forming an eighth construct. The revised survey assesses student opinion of how important they deem elements of the eight constructs, using a Likert-type scale as follows:

1: Not important at all

2: Mostly not important

3: Neutral

4: Somewhat important

5: Extremely important

The pre-intervention version of the survey (Form A) includes nine demographic questions and 37 items asking participants to rate importance of a specific construct element (see Appendix 1). The post-intervention version (Form B) includes the same 37 importance-rating items, followed by three follow-up questions for each of the eight constructs that explore student incorporation of constructs in capstone designs (yes or no), preferred timing of educational intervention (planning, design, or implementation), and possible challenges to construct inclusion (see Table II).

### D. Educational Intervention and Procedure

Following survey instrument design, we modified the learning intervention in several aspects: 1) the intervention is made available as an online presentation, 2) clarify constructs and add an AI/ML module, and 3) standardize the presentation across constructs. All elements were organized into a PowerPoint presentation, with each construct explanation including a definition, dichotomous examples, and "what you can do," suggestions to provide options for design incorporation. Table I summarizes presentation content for each of the eight constructs. We initially planned to present the educational intervention synchronously and record should participating students desire subsequent access. However, due to time limitations at the semester end, the intervention was recorded by a senior psychology undergraduate research assistant and uploaded for asynchronous viewing.

Table I. A mapping of the proposed framework constructs and the practical "nudges" shared with students during the education presentation.

| Construct | Suggested Design Features | Design Pitfalls |
|---|---|---|
| Privacy and Use of Data | *Carefully define what data is needed for your product<br>*Identify any data that your product is collecting that is sensitive in nature<br>*Incorporate the appropriate safeguards to protect that data<br>*Include appropriate mechanisms to enable the user to manage their data | *Highly sensitive data collected and improperly stored<br>*Focus on financial gains placed before protection of sensitive data |
| Components of Consent | *Make sure information regarding purpose and intent, possible risks, customer support, and liability waivers are easily accessible<br>*Users can view terms of use document<br>*Users can understand it<br>*Include mechanisms to offer different consent choices and enable users to confirm their own choices | *Difficult to read and full of legal terminology<br>*Critical information embedded in a lengthy document<br>*Cancellation process designed to be difficult for user |
| Unintended Consequences | *Provide ways of measuring and tracking unintended outcomes<br>*Provide additional resources as needed | *No mechanisms to detect or monitor bad actors<br>*No pre-launch testing for ways opportunists might utilize product to harm others |
| Participatory and Inclusive Design | *Involve diverse participants<br>*Take a "user centered" approach<br>*Regularly seek feedback from users during the design process | *Ignores sub-group needs and preferences of larger target audience<br>*Eliminate research or feedback mechanisms after product launch |
| Choice Architecture | *Structure the choice environment to guide users toward specific outcomes while maintaining user autonomy<br>*Design product responsibly using defaults, placement categorization, visuals, and nudges | *Curtail user function with poorly designed choice architecture<br>*Stymie users in meeting their own goals |
| User Motivation and Engagement | *Integrate motivational and/or engagement elements aligned with intended outcomes<br>*Draw on psychological principles during the design process<br>*Assess features that enhance user engagement for potential to harm versus user benefit | *Product designed to be addictive<br>*Techniques such as infinite scrolling, auto-playing videos and "likes" used to manipulate behavior of user and push for unhealthy engagement<br>*Driving force behind user engagement lies in the developer's push for profit |

| | | |
|---|---|---|
| Measurements of Outcomes and Efficacy | *Clearly define the behavior being observed<br>*Ensure that measurement tools are valid<br>*Beyond behavior, assess user satisfaction and experience | *Measurement tool lacks validity<br>*User Satisfaction after reaching/not reaching goal not measured |
| Artificial Intelligence/ ML | *Assess AI data to avoid bias<br>*Mention use of AI in product development<br>*Vary question phrasing context and complexity<br>*Identify likelihood that AI could result in disruption of the workforce | *Consequences of using AI generated images not considered and outcome was a significant disruption to the workforce<br>*Product launched and used for over a year before recognizing problematic bias |

**Pilot Study Results**

The study was administered as a quick pilot closer to the end of the Fall semester to test the study protocol, surveys integration with the LMS, and the intervention recording. A small count of students participated in this pilot run, 19 students completed Form A and 9 completed both pre- and post- surveys. Caution is warranted when interpreting these results due to the small sample size and the nature of piloting the study protocol near the final exams time. We include the following commentary in acknowledgment of possible ways this may have affected the results we share here. Participating students may have differed from nonparticipating students in ways that influence results. For example, the small sample may be biased to include students who would take time to complete the present study for extra credit. Students for whom "not enough time" may have been the most salient application challenge may have declined to participate in the study. Alternatively, that the majority of students did not participate may indicate a general lack of interest in ethical/psychological components of product design. If our respondents included those who have an unusually high level of interest in the topic, this may have depressed the number of "did not care about the construct" endorsements we received on Form B. While these possibilities cannot be ruled out, we note that students were not recruited until later in the semester, at a point when they may have been certain of their course grades or needed to prioritize final exams.

**A. Participants**

Study participants included undergraduate students enrolled in three sections of a senior engineering capstone design courses at Texas A&M University. We recruited students in coordination with their instructor, who offered the survey and an additional non-research option for extra credit. One hundred students were enrolled across all sections, out of which nineteen (14 male-identifying students and 5 female-identifying students) responded to Part A of the survey. Students ranged in age from 22-26 years old. Nine students completed both pre- and post-intervention surveys.

Prior to the intervention, all 19 participants were asked to rate their current confidence in their ability to apply ethical and psychological principles to their capstone projects. Figure 5 depicts these results. Most students were nearing project completion at time of survey; therefore, this question provides a retrospective opinion. Most students (68%) reported feeling either highly confident or somewhat confident in terms of ability to apply relevant principles to their projects. In a related question, students were also asked whether they had encountered exposure to ethical/psychological concepts in previous courses. Figure 6 summarizes the proportion of students who endorsed, denied, or were not certain about previous learning. Most students endorsed prior exposure (68%), though a significant minority (26%) indicated uncertainty.

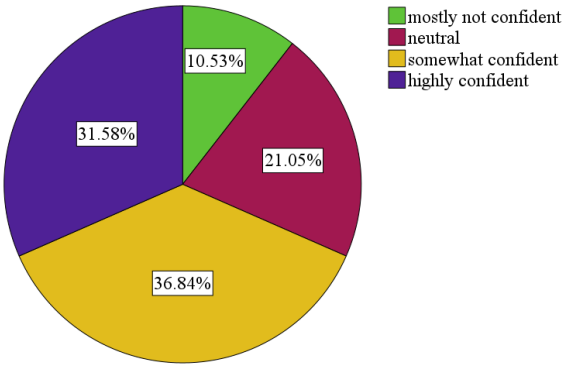


Figure 5. Self-rated confidence (pre-intervention) in ability to apply ethical/psychological principles, (Form A; n = 19).

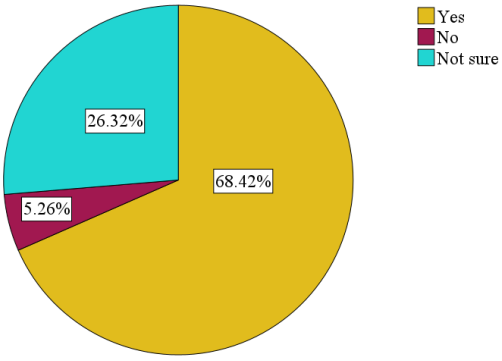


Figure 6. Recollection of previous exposure to ethical/psychological constructs (Form A; n = 19)

## B. Challenges to Design Application

Sample size (N = 9) of students completing the post-intervention survey was limited; we therefore report results in frequency format and interpret cautiously. Participants were asked whether they had applied a construct to their project; if they responded "no," a follow-up question was displayed. Students were then presented with six possible challenges that may have prevented construct application to their capstone project. For each of the eight constructs, participants were presented the full list of challenges and asked the "check all that apply." Table II summarizes the challenges most frequently endorsed for each construct, as well as challenges that were not endorsed.

Intriguing trends are noted for follow-up in future studies. Lack of time to apply the construct was never endorsed as a challenge, with the exception of AI/ML principles. Students did not perceive that ethical/psychological features would compromise other design functions and rarely endorsed not knowing how to incorporate constructs. The most frequently endorsed challenges across constructs were: not finding a construct relevant to their project, the construct not being a graded aspect, or not caring about the construct.

**Commented [EH1]:** Still need to comment here

## C. Timing of Design Application

Whether they had incorporated the construct or not, all nine Form B respondents were asked their opinion regarding timing application of ethical/psychological construct during product development. They could select one of the following options: planning, design, implementation, or testing. Results were fairly similar across constructs, with the exception of AI/ML. No students endorsed implementation as an ideal time for incorporation within AI/ML-relevant products. The planning stage was most frequently endorsed for incorporation of User Motivation and Engagement, Measurement of Outcomes, and AI/ML design features, whereas more students thought the design phase was most appropriate to consider the constructs of Privacy and Use of Data, and Choice Architecture.

Table II. Challenges of construct incorporation by ethical/psychological construct

| **Construct (Frequency of "no" responses)** | **Most Endorsed Challenges (Frequency Endorsed)** | **Challenges Not Endorsed** |
|---|---|---|
| **Privacy and Use of Data (6)** | Assessed but not found relevant (3)<br>Not on grading rubric (2) | Not enough time<br>Compromised another function |
| **Components of Consent (6)** | Assessed by not found relevant (4)<br>Not on grading rubric (3) | Not enough time<br>Did not understand how<br>Compromised another function |
| **Unintended Outcomes (1)** | Did not care about construct (1) | Not enough time<br>Assessed but not found relevant |

| | | |
|---|---|---|
| | | Not on grading rubric<br>Did not understand how<br>Compromised another function |
| **Participatory Design (4)** | Assessed but found not relevant (2) | Not enough time<br>Compromised another function |
| **Choice Architecture (3)** | Assessed but found not relevant (2)<br>Did not care about construct (1) | Not enough time<br>Not on grading rubric<br>Did not understand how<br>Compromised another function |
| **User Motivation & Engagement (4)** | Assessed but found not relevant (3) | Not enough time<br>Did not understand how<br>Compromised another function |
| **Outcome Measurement (2)** | Did not care about construct (1)<br>Assessed but found not relevant (1) | Not enough time<br>Not on grading rubric<br>Did not understand how<br>Compromised another function |
| **AI/ML (7)** | Not enough time (2)<br>Did not care about construct (2)<br>Assessed but found not relevant (4)<br>Not on grading rubric (2) | |

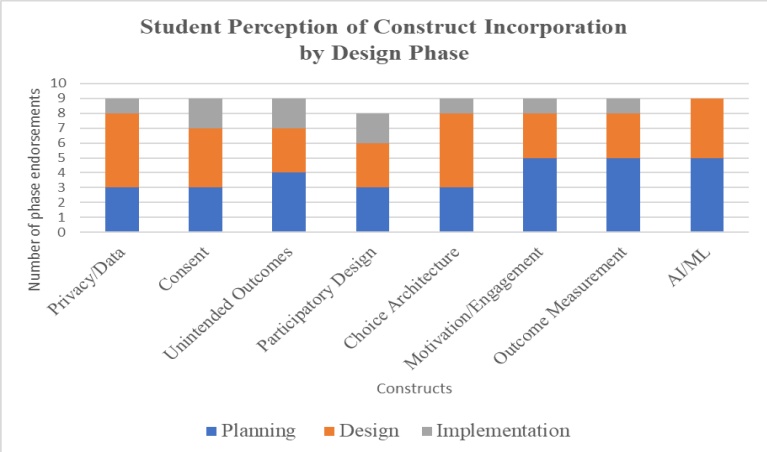

Figure 7. For each of the eight constructs, students endorsed either the Planning, Design, or Implementation phase of product development as the appropriate time to apply construct elements into design, (n = 9; Form B).

## DISCUSSION AND FUTURE WORK

In this paper we present an ethics and psychological safeguards framework for nudging capstone design project students. We expand on the design of the study instruments and background theory. We further detail the mapping of study constructs to practical "do and don't" suggestions that can be used in digital product design. Finally, we share the initial results from piloting the study in an engineering capstone design course.

Future work will focus on targeting a larger capstone class size across multiple majors. This would allow for statistical analysis of pre-post change and factor analysis of survey items to confirm or adjust the proposed structure of eight constructs. These results will be helpful in discerning the best context for the intervention, which could include classes that occur prior to capstone work and/or other engineering sub-disciplines. The limited response rate in the present study prevented these analyses and may represent problematic timing. Though incentivized with extra credit, student motivation to add another task at the end of the semester may have been quite low. The pilot initial results served to highlight important factors to consider when applying the study to larger student populations. Such factors include (1) time of application of the pre and post surveys relative to the product development cycle, (2) time between pre and post survey to allow time for students to think, evaluate, and possibly apply some elements of the framework as relevant to their capstone product. Increasing the time between pre and post survey dissemination and ensuring that Form A is made available prior to the planning and design phases of project development will also be helpful in testing hypotheses about confidence and previous learning in this content area. In future work, we will also investigate whether the high degree of confidence reported in this (albeit small) sample correlates with aptitude or whether there is to some degree a "false confidence," related to application of ethical and psychological constructs. Are students unaware of their blind spots and therefore overly confident, or does their confidence match applied abilities?

Future work will also examine the feasibility and benefits of possibly leveraging the study constructs, related survey items, and intervention slides to support grading rubric for capstone projects. Lack of representation on a grading rubric was endorsed as a reason for not including ethical/psychological constructs in project designs in our survey. To this end, future research efforts may entail presenting survey items to faculty and asking them to rate relevance to assigned capstone projects. In the marketplace, a structured and standardized means of assessing incorporation of ethical principles and human factors, as represented by behavioral psychology constructs, could provide consumers with means of comparing products on metrics that matter, but are often invisible to consumers. Much work is needed before such an instrument is market ready. In the near-term, utilizing survey results to understand how to more effectively nudge future engineers to design ethical products with human factors in mind is a worthy goal in and of itself.

## References


[1] U. C. Institute, "The Fastest-Growing and Fastest-Declining Industries in the United States (and Common Jobs in Those Fields)," US Career Institute, May 2023. [Online]. Available: https://www.usacareerinstitute.edu/blog/The-Fastest-Growing-and-Fastest-Declining-Industries-in-the-United-States. [Accessed 18 02 2025].

[2] Y. Lee, M. Chui and R. Roberts, "McKinsey Technology Trends Outlook 2024," McKinsey, 16 July 2024. [Online]. Available: https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/the-top-trends-in-tech. [Accessed 18 2 2025].

[3] Comscore, "Smartphone Apps Are Now 50 of All U.S. Digital Media Time Spent," 1 September 2016. [Online]. Available: https://www.comscore.com/Insights/Blog/Smartphone-Apps-Are-Now-50-of-All-US-Digital-Media-Time-Spent.

[4] ABET, "Accreditation Criteria and Supporting Documents," ABET, [Online]. Available: https://www.abet.org/accreditation/accreditation-criteria/. [Accessed 10 January 2025].

[5] A. Narayanan and S. Vallor, "Computing Ethics: Why Software Engineering Courses Should Include Ethics Coverage," *Communications of the ACM,* vol. 57, no. 3, pp. 23-25, 2014.

[6] B. J. Grosz, D. G. Grant, K. Vredenburgh, J. Behrends, L. Hu, A. Simmons and J. Waldo, "Embedded EthiCS: integrating ethics across CS education," *Communications of the ACM,* vol. 8, no. 62, pp. 54-61, 2019.

[7] B. J. Grosz, D. G. Grant, K. Vredenburgh, J. Behrends, L. Hu, A. Simmons and J. Waldo, "Embedded Ethics: integrating ethics across CS education," *Communications of the ACM,* vol. 62, no. 8, pp. 54-61, 2019.

[8] H. Golecki and J. Bradley, "Experiential Learning: Exploring Nuances When Making Ethical Decisions in a Capstone Design Course," *Biomedical Engineering Education,* vol. 4, no. 1, pp. 163-170, 2024.

[9] O. C. Ugweje and K. N. Bowlyn, "Engineering Ethics Education for a Capstone Design Project Course," in *ASEE North East Section*, 2024.

[10] C. Brown and C. Parnin, "Nudging Students Toward Better Software Engineering Behaviors," in *IEEE/ACM Third International Workshop on Bots in Software Engineering (BotSE)*, 2021.

[11] E. Schmitt, B. Morkos, E. Kames and T. A. Conway, "The Importance of Incorporating Designer Empathy in Senior Capstone Design Courses," in *ASEE Annual Conference and Exposition*, 2016.

[12] W. IJsselsteijn, Y. De Kort, C. Midden, B. Eggen and E. Van Den Hoven, "Persuasive technology for human well-being: Setting the scene," in *PERSUASIVE 2006, Persuasive Technology: First International Conference on Persuasive Technology for Human Well-Being*, Eindhoven, 2006.

[13] P. Atieh, E. Hammad and C. Riley, "Ethical Safeguards & Behavioral Psychology Competencies: A Framework for Computer Science Capstone Project Design," in *IEEE Frontiers in Education Conference (FIE)*, College Station, 2023.

[14] A. J. Thomson and D. L. Schmoldt, "Ethics in Computer Software Design and Development," *Computers and Electronics in Agriculture,* vol. 30, no. 1-3, pp. 85-102, 2001.

[15] L. L. Dhirani, N. Mukhtiar, B. S. Chowdhry and T. Newe, "Ethical Dilemmas and Privacy Issues in Emerging Technologies: A Review," *Sensors,* vol. 23, no. 3, p. 1151, 2023.

[16] M. Scoutas, "Comscore Research Captures Evolving Consumer Mobile Behavior," Comscore, Inc., 18 November 2020. [Online]. Available: https://www.comscore.com/Insights/Press-Releases/2020/11/Comscore-Research-Captures-Evolving-Consumer-Mobile-Behavior. [Accessed 6 January 2025].

[17] K. Shilton and D. Greene, "Linking platforms, practices, and developer ethics: Levers for privacy discourse in mobile application development," *Journal of Business Ethics,* vol. 155, pp. 131-146, 2019.

[18] J. Davis, "Design methods for ethical persuasive computing," in *Proceedings of the 4th International Conference on Persuasive Technology*, 2009.

[19] B. Green, D. Lim and E. Ratte, "Responsible Use of Technology: The Microsoft Case Study," World Economic Forum, 2021.

[20] E. Sarafino, applied behavior analysis: principles and procedures for modifying behavior, Whiley, 2012.

[21] B. J. Fogg, "A Behavioral Model for Persuasive Design," in *Proceedings of the 4th international Conference on Persuasive Technology*, 2009.

[22] R. H. Thaler and C. R. Sunstein, Nudge: Improving Decisions About Health, Wealth, and Happiness, Penguin, 2009.

[23] A. Camilleri and R. P. Larrick, "Choice Architecture," in *Emerging Trends in the Social and Behavioral Sciences.*, Wiley and Sons, 2015.

[24] T. C. Leonard, R. H. Thaler and C. R. Sunstein, Nudge: Improving Decisions About Health, Wealth, and Happiness, New Haven: Yale University Press, 2008.

[25] C. Reeck, N. A. Posner, K. Mrkva and E. J. Johnson, "Nudging app adoption: Choice architecture facilitates consumer uptake of mobile apps," *Journal of Marketing*, vol. 87, no. 4, pp. 510-527, 2023.

[26] Z. H. Morford, B. N. Witts, K. J. Killingsworth and M. P. Alavosius, "Gamification: The intersection between behavior analysis and game design technologies," *The Behavior Analyst*, vol. 37, pp. 25-40, 2014.

[27] P. Phogat and V. Verma, "Efficacy of Mental Health Apps and Related Tools on Social Media: A Systematic Review of Researches," *IAHRW International Journal of Social Sciences Review*, vol. 11, no. 1, 2023.

[28] K. M. Palmer and V. Burrows, "Ethical and safety concerns regarding the use of mental health-related apps in counseling: Considerations for counselors," *Journal of Technology in Behavioral Science*, vol. 6, no. 1, pp. 137-150, 2021.

[29] A. D. Hernández and V. Galanos, "A toolkit of dilemmas: Beyond debiasing and fairness formulas for responsible AI/ML," *IEEE International Symposium on Technology and Society*, vol. 1, pp. 1-4, 2022.

[30] M. Walid, Y. D. Pham and L. Chazette, "Tailoring Requirements Engineering for Responsible AI," *Computer*, vol. 56, no. 4, pp. 18-27, 2023.

[31] M. Sadek, M. Constantinides, D. Quercia and C. Mougenot, "Sadek, Malak, Marios Constantinides, Daniele Quercia, and Céline Mougenot. "Guidelines for Integrating Value Sensitive Design in Responsible AI Toolkits," in *Proceedings of the CHI Conference on Human Factors in Computing Systems*, 2024.

[32] U. M. a. Communications, "Content Readability," Michigan Tech University, [Online]. Available: https://www.mtu.edu/umc/services/websites/writing/readability/. [Accessed 10 January 2025].

## Appendix I:

### Condensed Form A (Part I and Part II) used for Data Collection

**Part I**

| | | |
|---|---|---|
| 1 | How do you describe your gender identity? | Male, Female, Nonbinary, Intersex, Transgender male, Transgender female, Gender identity not listed here, Prefer not to disclose |
| 2 | Age | |
| 3 | How do you identify? | American Indian, Alaska Native and/or Indigenous<br>Arab American, Middle Eastern, or North African<br>Black or African American<br>Bi/multi-racial<br>Latino/a/x or Spanish origin<br>Native Hawaiian or Pacific Islander<br>Southeast Asian |

| | | |
|---|---|---|
| | | White or European American<br>Another identity not listed<br>Prefer not to answer |
| 4 | How would you categorize your college minor? | Not applicable/no minor<br>Agriculture and Life Sciences<br>Business, Marketing, or Related Field<br>Humanities or Social Sciences<br>Interdisciplinary Studies<br>Performance or Fine Arts<br>STEM (Science, technology, engineering or math) |
| 5 | Does your current capstone technology innovation employ AI/ML technology? | Yes, No |
| 6 | Do you recall learning about psychological or ethical principles in previous classes? | Yes, (list the course(s) if you remember)_____<br>_____<br>No<br>Not sure |
| 7 | If yes, did your learning experience involve (check all that apply) | Case studies<br>Discussion<br>Design project<br>Essay response<br>Application of ethical or psychological principles |
| 8 | How confident are you in your ability to identify ethical or psychological principles that may be relevant to your product design? | 1 not confident at all<br>2 mostly not confident<br>3 neutral<br>4 somewhat confident<br>5 highly confident |

**Part II**

Please circle the rating which best describes the relationship between the design element described and your app product.

2 = Highly relevant (HR), 1 = Somewhat relevant (R), 0 = Neutral (N), -1 = Not relevant (NR)

| | **Privacy and Use of Data** | **HR** | **R** | **N** | **NR** |
|---|---|---|---|---|---|
| 1 | Identifying user data, collected during product download or use, that is sensitive in nature | 2 | 1 | 0 | -1 |
| 2 | Incorporating ways to protect the privacy of any sensitive information collected from users | 2 | 1 | 0 | -1 |
| 3 | Allowing users to opt out of providing some types of information about themselves | 2 | 1 | 0 | -1 |
| 4 | Allowing users to access and control their data | 2 | 1 | 0 | -1 |
| | SCORE PRIVACY | | | | |
| | **Components of Consent** | **HR** | **R** | **N** | **NR** |

| | | | | | |
|---|---|---|---|---|---|
| 5 | Providing an easy to understand and access terms of use document | 2 | 1 | 0 | -1 |
| 6 | Describing the purpose or functions of product to the user | 2 | 1 | 0 | -1 |
| 7 | Reviewing potential risks and benefits of using the product | 2 | 1 | 0 | -1 |
| 8 | Mentioning other ways of accomplishing the product's purpose | 2 | 1 | 0 | -1 |
| 9 | Describing any liability waivers, or things the company is not responsible for | 2 | 1 | 0 | -1 |
| 10 | Informing users on how to contact customer support | 2 | 1 | 0 | -1 |
| | SCORE CONSENT | | | | |
| | **Unintended Outcomes and Safeguards** | **HR** | **R** | **N** | **NR** |
| 11 | Identifying types of unexpected results, like if someone uses the product in a way that hurts someone else | 2 | 1 | 0 | -1 |
| 12 | Considering ways to prevent or minimize the risk of unexpected or harmful results | 2 | 1 | 0 | -1 |
| 13 | Measuring whether unintended results are happening, and how often they occur | 2 | 1 | 0 | -1 |
| 14 | Providing user support or additional resources for in the event of unintended or harmful results | 2 | 1 | 0 | -1 |
| | SCORE OUTCOMES | | | | |
| | **Participatory and Inclusive Design** | **HR** | **R** | **N** | **NR** |
| 15 | Conducting research with a teamwork approach between designers and users | 2 | 1 | 0 | -1 |
| 16 | Allowing users to provide feedback to shape how the product adapts for future use | 2 | 1 | 0 | -1 |
| 17 | Designing the product in ways that enhance its ease of use, visual presentation, and audio features for users who might otherwise have difficulty | 2 | 1 | 0 | -1 |
| 18 | Considering which languages or translation options users might need | 2 | 1 | 0 | -1 |
| | SCORE PARTICIPATORY | | | | |
| | **Choice Architecture** | **HR** | **R** | **N** | **NR** |
| 19 | Allowing users to customize their experience in ways that align with their goal(s) | 2 | 1 | 0 | -1 |
| 20 | Presenting choices in a way that is not manipulative or too restricting | 2 | 1 | 0 | -1 |
| 21 | Providing options that "nudge" or guide the consumer, in ways that support the users' own goals | 2 | 1 | 0 | -1 |
| | SCORE CHOICE ARCHITECURE | | | | |
| | **User Motivation and Engagement** | **HR** | **R** | **N** | **NR** |
| 22 | Learning which psychological principles, such as motivation or behavior change, are most important to product design | 2 | 1 | 0 | -1 |
| 23 | Assessing which features encourage user engagement to benefit the user, and which ones benefit the developer | 2 | 1 | 0 | -1 |
| 24 | Ensuring that product features designed to engage the user, or increase use, also support the user's goals | 2 | 1 | 0 | -1 |
| | SCORE MOTIVATION & ENGAGEMENT | | | | |
| | **Management of Outcomes and Efficacy** | **HR** | **R** | **N** | **NR** |
| 25 | Identifying target behavior(s) to measure that are meaningful to the user | 2 | 1 | 0 | -1 |
| 26 | Conducting research to make sure the measurement tools used are really accurate | 2 | 1 | 0 | -1 |
| 27 | Including a way to measure user satisfaction after they use the product | 2 | 1 | 0 | -1 |
| 28 | Assessing user well-being during or after technology use | 2 | 1 | 0 | -1 |
| | SCORE OUTCOMES | | | | |
| | **Artificial Intelligence and Machine Learning** | **HR** | **R** | **N** | **NR** |
| 29 | Disclosing whether designers used AI or analytics to improve the product experience | 2 | 1 | 0 | -1 |
| 30 | Explaining how the algorithms used in the product decide what information to use or ignore when they're learning and making decisions | 2 | 1 | 0 | -1 |

| | | | | | |
|---|---|---|---|---|---|
| 31 | Describing methods used to make the algorithms in a way users can understand | 2 | 1 | 0 | -1 |
| 32 | Testing different user questions and prompts to AI to prevent undesired or harmful outcomes | 2 | 1 | 0 | -1 |
| 33 | Assessing original data for accuracy to avoid spreading biased or false information through AI/ML | 2 | 1 | 0 | -1 |
| 34 | Identifying significant safety or security risks, and informing the user in the event of an AI/ML product malfunction | 2 | 1 | 0 | -1 |
| 35 | Evaluating the likelihood that an AI/ML application could result in sudden and/or significant disruption in the workforce of a particular field | 2 | 1 | 0 | -1 |
| 36 | Developing ways to track the ownership of AI generated artifacts | 2 | 1 | 0 | -1 |
| 37 | Confirming whether the AI response refers the user to other credible sources of information | 2 | 1 | 0 | -1 |