

UX Remix: Improving Measurement Item Design Process Using Large Language Models and Prior Literature

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Abstract

Researchers often struggle to develop measurement items and lack a standardized process. To support the design process, we present UX Remix, a system to help researchers develop constructs and measurement items using large language models (LLMs). UX Remix leverages a database of constructs and associated measurement items from previous papers. Based on the data, UX Remix recommends constructs relevant to the research context. The researchers then select appropriate constructs based on the recommendations. Afterward, selected constructs are used to generate a custom construct, and UX Remix recommends measurement items. UX Remix streamlines the process of selecting constructs, developing measurement items, and adapting them to research contexts, addressing challenges in the selection and reuse of measurement items. This paper describes the implementation of the system, the potential benefits, and future directions to improve the rigor and efficiency of measurement design in human-computer interaction (HCI) research.

Keywords

User experience, Constructs, Measurement items, Evaluation, Large language models

1. Introduction

As the scope of computing has expanded, evaluating user experience (UX) in interactive systems has become increasingly important. One of the most widely adopted methods for evaluating UX is conducting studies with interactive systems and subsequently collect survey data regarding constructs from users [1]. Therefore, to design a survey for the study, researchers must create measurement items for the specific constructs they want to evaluate. To develop measurement items, they often leverage measurement items used in prior research [1, 2, 3, 4, 5]. The simplest approach is to utilize well-established questionnaires that are commonly used in human-computer interaction (HCI) research [2, 3, 5]. For instance, researchers can utilize a system usability scale (SUS) [6], a NASA task load index (NASA-TLX) [7], a user burden scale (UBS) [8], a questionnaire for user interaction satisfaction (QUIS) [9], and a user experience questionnaire (UEQ) [10] to measure the well-known constructs such as usability, usefulness, and ease-of-use. Another approach is to adopt measurement items of constructs from previous studies in related fields [1, 11]. However, finding and adopting similar constructs and measurement items from related research is challenging [1, 12, 13]. In addition, when the

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research context differs from previous research, existing measurement items may not be entirely appropriate. In this case, researchers should modify existing measurement items or develop new items [1, 5, 12, 14, 15].

Designing measurement items lacks a standardized process, so researchers should explore various studies to collect and modify measurement items [1, 11, 15, 16]. In some cases, measurement items are not publicly available and there are often no guidelines to modify measurement items [1]. Consequently, researchers should manually investigate relevant studies that have addressed similar constructs, extract measurement items, and adapt them to their specific research context [1, 5, 12, 14, 15]. This process is both time-consuming and resource-intensive [17]. Furthermore, instead of reusing the measurement items developed in previous research, researchers often develop new measurement items [1, 16]. However, this practice can compromise the reliability and rigor of the measurement items. Inefficiencies and inconsistencies inherent in the measurement item design process highlight the need for methodological improvements in HCI research.

Despite the challenges associated with the design of measurement items in HCI research, there has been limited exploration of systems to assist this process [18]. Therefore, we introduce a system, UX Remix, supporting the design of measurement items for evaluation in HCI research. UX Remix uses constructs and associated measurement items from prior research. UX Remix then generates a custom construct and measurement items tailored to the evaluation purpose through an LLM. Researchers can utilize the system to customize the construct aligned with their research contexts and develop measurement items accordingly. We expect researchers to be able to improve the process of finding relevant constructs and developing measurement items for evaluation using UX Remix.

In this paper, we introduce the detailed measurement item design process with UX Remix. First, we describe the process of collecting previous literature and extracting information to build a database of constructs and their measurement items. Subsequently, we present the implementation of UX Remix and its core pages using the collected items. Finally, we discuss the potential and future directions of UX Remix.

2. Related Works

Surveys are widely used to assess the effectiveness of interactive computing systems [1, 2, 5, 19]. To evaluate UX, selecting the appropriate measurement items for surveys is an important yet challenging [12, 13, 20, 21]. Consequently, evaluation has often relied on long-established questionnaires [1, 2, 5, 20] such as SUS [6], NASA-TLX [7], UEQ [10], QUIS [9], UBS [8], and more. Although these surveys are credible and widely adopted, they primarily focus on general constructs such as usability, utility, and ease of use [4, 18]. As a result, they are often insufficient for measuring more diverse aspects of UX [2, 3, 12, 17, 22]. Therefore, previous research has explored and proposed methods for designing surveys and measurement items specific to domains [12, 20] such as mixed reality [23, 24], robotics [25, 26], conversational agents [4, 27, 28], and smart home [29, 30].

Designing constructs and measurement items that align with specific research contexts still remains a difficult work, because researchers adopt different approaches to designing

measurement items, including modifying existing items or developing new ones [1, 2, 5, 12]. Perrig et al. analyzed 85 distinct questionnaires in 153 papers from proceedings of the ACM Conference on Human Factors in Computing Systems (ACM CHI conference proceedings) published between 2019 and 2022 [1]. Most of these questionnaires were used only once (70.59%), and 55% of the papers modified their measurement items to fit their research by rewriting items, deleting irrelevant items or utilizing only items appropriate to the research context. Darin et al. emphasized that in survey-based evaluation, researchers should carefully select measurement items that align with evaluation objectives and apply them in an appropriate context [2]. They highlighted the importance of considering the reuse of existing validated measurement items and adopting approaches that extend or adapt them as needed. Previous studies indicate that researchers frequently encounter difficulties in finding suitable measurement items, often resorting to compiling items from various studies or developing new ones [1, 2, 5, 12]. These processes are time-consuming and resource-intensive [17], underscoring the need for more standardized and accessible measurement practices.

To address the challenges of designing measurement items in evaluation, recent work by Zheng et al. proposed a system that supports metric exploration for evaluation planning [18]. Their system leveraged large language models (LLMs) to help researchers explore appropriate metrics for their evaluation plans. The system enabled researchers to design comprehensive and systematic evaluation plans. Their research demonstrated the potential of LLMs to recommend and design suitable metrics for evaluation. However, their system primarily focused on metric exploration and did not address the development of measurement items.

Based on the literature review, our research focuses on the process for designing constructs and measurement items. We introduce a system that utilizes an LLM to recommend constructs and develop measurement items tailored to specific evaluation purposes. The researchers can then design a custom construct and develop its measurement items using the system. We aim to enhance the re-usability of measurement items from previous studies and facilitate the development of measurement items for evaluation.

3. UX Remix

To support the design process of the constructs and measurement items for evaluation, we developed UX Remix. Based on constructs and measurement items from the previous literature, UX Remix recommends appropriate constructs and measurement items that align with current research objectives. Using these recommendations, researchers can customize constructs and configure measurement items to suit their specific research context.

To develop the system, we first collected survey-based constructs and measurement items from previous HCI literature. We utilized an LLM to extract information about the constructs and pre-process them. The collected constructs and measurement items were stored in a vector database, which served as a foundation for implementing UX Remix. UX Remix receives input from researchers about the project description, and the input is used for a vector search to recommend the 10 most relevant constructs. The researchers can then select the constructs that best align with their evaluation purposes. Based on the selected constructs, the system utilizes an LLM to generate a custom construct, refine the measurement items, and classify

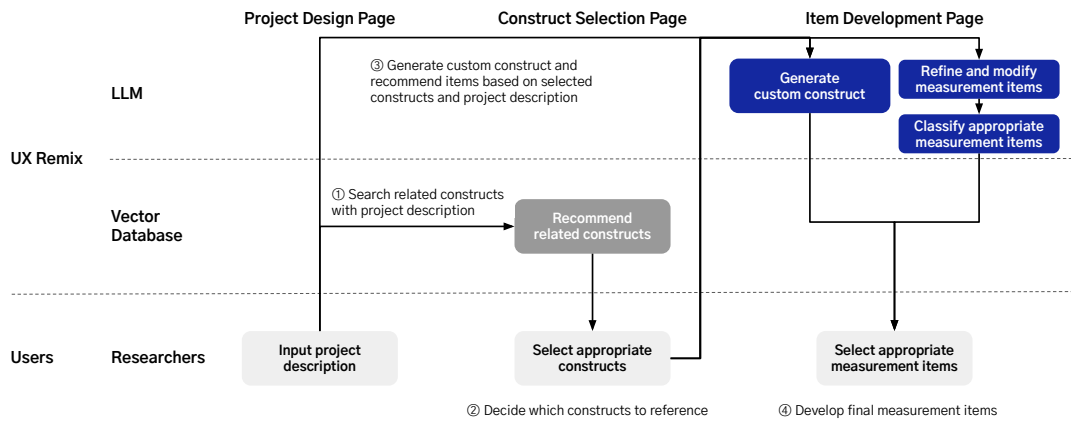


Figure 1: In UX Remix, users (researchers) fill out the project descriptions. (1) The vector database searches for 10 related constructs and recommends them to users based on the project description. (2) Users select the appropriate constructs that would be used as prompts in a large language model (LLM). (3) LLM generates a custom construct and measurement items for evaluation. (4) Users develop measurement items using recommendations of the LLM.

them as aligned or misaligned with the purpose of the evaluation, providing the researchers with recommendations accordingly. The researchers can then configure the most appropriate measurement items for their research. The details of UX Remix are below.

3.1. Data Collection and Preprocessing

To collect constructs and measurement items, we gathered papers published in HCI-related conferences and journals: (1) ACM SIGCHI-sponsored conferences and journals, (2) SCIE (Science Citation Index Expanded) journals such as International Journal of Human-Computer Studies, Interacting with Computers, Computers in Human Behavior, etc. (3) Other conference and journal papers in the fields of information science, cognitive science, and psychology. Therefore, we used the following search query to find literature:

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("questionnaire" OR "scale" OR "measurement items" OR "items" OR "metric" OR "measurement") AND "Likert" AND (HCI OR Human-Computer Interaction) AND "[journal or conference name]"
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The query was used to find various constructs and measurement items in HCI-related papers. It consists of keywords on measures (*questionnaire, scale, measurement items, items, metric, measurement, Likert*), field (*HCI, Human-Computer Interaction*), and name of publications. The papers were searched in Google Scholar and the ACM Digital Library. Each paper was reviewed by the authors. If constructs and measurement items were explicitly mentioned, they were included in the paper database. Even if the same construct name or measurement items appeared in different papers, they were collected separately. As a result, a total of 697 constructs were identified from 185 research papers.

To extract information from the papers, we utilized a ChatGPT GPT-4o model. Based on the previous paper using an LLM to analyze metrics [18], we designed the GPT to extract the

constructs and information of the papers. The GPT extracted the following constructs and paper-related information: construct name, construct definition, construct usage, point and type of measurement items, measurement items, the number of measurement items, title of the paper, and APA format of the paper. We extracted the information from each paper and stored them in the paper database. The details of our GPT are described in the Appendix A.1.

After extracting information from the papers, we pre-processed the measurement items of the data. Since the measurement items were originally designed in the context of previous studies, we revised them by replacing specific contextual terms with the generalized term “[Evaluation Target]”. We also utilized an LLM to perform data pre-processing. The rewording of the measurement items was carried out using the following prompt: “Please rewrite the above items by replacing the specific term like [system name or feature] with a generalized term like [Evaluation Target]. If there is no specific term, do not change the items. Keep the structure and format of the sentences unchanged”. A total of 697 constructs’ measurement items were reworded accordingly. For instance, the item “I could get a robot to perform a specific task.” was modified to “I could get a [Evaluation Target] to perform a specific task.”

To utilize the collected data for construct recommendation, the constructs were stored in a vector database. We used the Qdrant database as the vector database, storing all the extracted constructs and information from the papers. In the vector database, embedding vectors were generated using details of the constructs such as construct name, construct definition, construct usage, and measurement items to facilitate vector-based similarity search. To generate embedding vectors, we utilized a “text-embedding-004” model of Google. The embedding vectors have a dimension of 768, and cosine similarity was employed for vector search.

3.2. System Design and Implementation

Our UX Remix system was implemented as a web-based system. The primary objective of the system is to help researchers easily design constructs and measurement items in evaluation. To achieve the purpose, we developed the system with three core pages, enabling researchers to select the constructs and develop the measurement elements effectively (see Figure 1). The three pages are as follows: (1) project design page, (2) construct selection page, and (3) item development page.

3.2.1. Project Design Page

On the project design page, the researchers fill in the basic project description about their project (see Figure 2). They first enter the project title. Then, they write the description of the system, the purpose of the evaluation, and the hypothesis design (the interactive features of the system and the core user experience). In the system description section, they enter the one-line description of the system or product being evaluated (e.g., AI-powered emotional chatbot). The evaluation purpose section receives the key aspects they want to explore through research (e.g., “*I want to study how the anthropomorphism of an AI chatbot affects users’ trust*”).

After that, researchers can fill in the hypothesis design section based on the evaluation purpose. The hypothesis design section includes interactive features and core user experience,

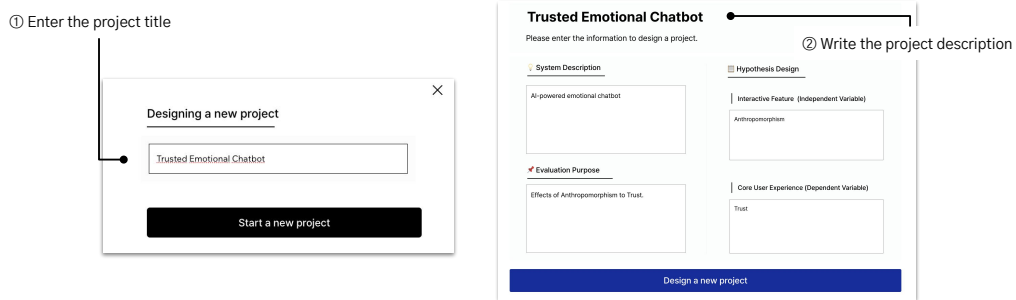


Figure 2: Project design page of UX Remix. In this page, researchers write a short project description.

which correspond to independent and dependent variables in a hypothesis, respectively. For instance, if the evaluation purpose is *“I want to study how the anthropomorphism of an AI chatbot affects users’ trust”*, then the interactive feature could be *“anthropomorphism”*, and the core user experience could be *“trust”*.

Once all sections are entered, the system stores the basic project description, which will be used to recommend the appropriate constructs and measurement items.

3.2.2. Construct Selection Page

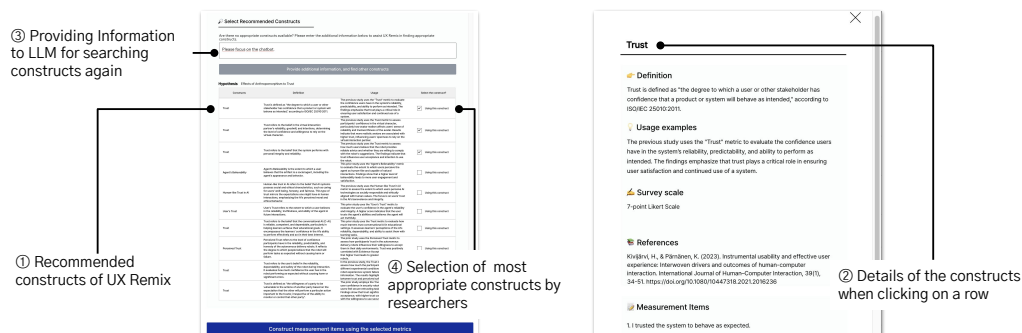


Figure 3: Construct selection page of UX Remix. UX Remix recommends 10 constructs relevant to the project description. Then, researchers select appropriate constructs based on the details.

On the construct selection page, researchers select the most appropriate constructs for their evaluation purposes based on the recommendations of the system (see Figure 3). First, the hypothesis is generated using the interactive feature provided and the core user experience. The recommended constructs are then displayed under hypothesis.

The 10 most relevant constructs are recommended based on the evaluation purpose and the core user experience. To achieve this, the system queries a vector database, retrieving the constructs with the highest cosine similarity to the evaluation purpose and the core user experience. Initially, the system searches for 20 constructs with the highest cosine similarity

to the core user experience. After that, among these, 10 constructs with the highest cosine similarity to the evaluation purpose are selected and presented.

The constructs retrieved from the vector database are displayed in a tabular format at the bottom of the construct selection page. The table includes columns for the construct name, the construct definition, and the usage of the construct, with a final column allowing researchers to select whether to include the construct in their evaluation. Clicking on a row in the table shows a modal window overlay that provides detailed information about the clicked construct, such as measurement items, points, and scale type.

If there is no appropriate constructs, researchers can provide additional information to the system, which is then utilized to retrieve new relevant constructs. The constructs already selected by the researchers are retained, while the other constructs are replaced by newly retrieved constructs. This approach enables researchers to receive recommendations for constructs that are more suitable to their research contexts.

The selected constructs are used in the item development to customize a construct and design measurement items.

3.2.3. Item Development Page

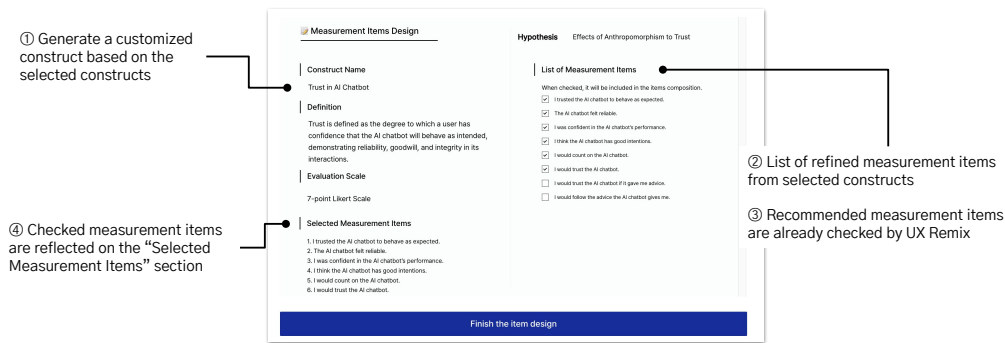


Figure 4: Item development page of UX Remix. UX Remix first generates a custom construct based on the selected constructs from previous page. Then, it refines the measurement items from the selected constructs and recommends most appropriate items to the custom construct. After that, researchers could decide most appropriate items based on the recommendation results.

On the item development page, researchers design a custom construct and corresponding measurement items tailored to the purpose of the evaluation based on the selected constructs (see Figure 4). At the top of the page, project details and selected constructs are displayed. At the bottom, the name, definition, point, and scale of the custom construct and measurement items are generated based on the selected constructs. Moreover, measurement items are modified to fit the current research context and presented as a checkable list.

The system utilizes an LLM on the back-end to generate the custom construct and modify the measurement items. We have employed a Google Gemini 2.0 Flash model as an LLM. The name, definition, point, and scale of the custom construct are generated by the LLM based on the names, definitions, points, and scales of selected constructs (see Appendix A.2 for detailed

prompts). For measurement items, the LLM considers system description, evaluation purpose, interactive features, core user experience, hypothesis, custom construct name, and custom construct definition to refine the items for the current research context (See Appendix A.3 for detailed prompts). In this process, the meaning and expression of the items are preserved, while irrelevant or unnecessary elements are modified or removed. Following refinement, the LLM distinguishes the appropriate and inappropriate items for current research purposes (see the Appendix A.4 for detailed prompts). The measurement items classified as appropriate are recommended by the system. The recommended items are pre-checked in the list of measurement items.

Researchers can review the custom construct and verify the modified measurement items. Furthermore, considering the recommended measurement items, they can further select the most suitable items or remove the unsuitable items for their research contexts and purposes. Through the procedure, users can design custom constructs and measurement items that are appropriate to their research contexts based on previous studies.

4. Discussion and Limitations

4.1. Tailoring Custom Measurement Items for Evaluation using LLMs

Recent work demonstrated that LLM can help explore metrics that align with the research context [18]. Furthermore, in this paper, we confirm that LLMs can design measurement items that fit to the current research context by leveraging a diverse set of constructs and measurement items. This finding suggests the potential to improve the measurement item design process in HCI research, which traditionally lacks a clear and standardized process [1, 11, 15, 16], using the prior literature and LLM.

In particular, adaptation of measurement items from previous studies is often required to fit the current research context [5]. The use of LLMs can shorten this process by supporting the selection, configuration, and modification of measurement items. Moreover, unlike commonly used constructs, such as usability, usefulness, and ease-of-use, it is challenging to find measurement items for less frequently measured constructs. Through leveraging vector database-based search, researchers can rapidly find similar constructs and utilize them to develop measurement items, thereby aiding the design of constructs and measurement items.

4.2. Enhancing Reliability and Rigor of Measurement Item Design

According to previous literature, measurement items have rarely been reused, and even when similar constructs exist, researchers often develop their own measurement items [1, 14]. The reasons for the tendency are due to differences in research contexts or the difficulty in identifying appropriate reusable measurement items [1]. Therefore, the pre-defined measurement items are underutilized in other studies, and the research often rely on traditional questionnaires. In particular, self-developed measurement items may have greater flexibility to contextualize, but it might be less rigorous or reliable compared to established or pre-defined measurement items.

However, reusing existing measurement items or appropriately combining them has the potential to improve rigor and reliability compared to self-developed measurement items [31, 32]

. Our system aims to assist researchers in designing constructs and measurement items based on previous constructs and measurement items, enabling them to tailor measurement items to specific research needs. Through the system, we anticipate greater assurance of the rigor and reliability of measurement items that are often overlooked in the evaluation.

4.3. Limitations and Future Work

Our work has several limitations and areas for improvement. First, the process of customizing constructs and designing measurement items using LLMs is inherently influenced by training data. Therefore, future research should consider potential biases and prevent them when using LLMs to design the measurement process. Additionally, the current approach to generating custom constructs and designing measurement items relies on prompts with specific rules that guide the appropriate merging of existing constructs and the contextual adaptation of measurement items without compromising their original meaning. It will be necessary to develop more refined prompt designs that reflect the survey validation process to ensure the rigor of both the constructs and the measurement items.

The system also has several limitations. Our system has not yet been evaluated and validated by user studies with researchers. To effectively support the questionnaire design process, we should collect feedback from them and refine the system accordingly. Moreover, our system currently lacks a sufficient number of constructs and measurement items. To cover a broader range of evaluations, it is essential to collect a diverse set of constructs and measurement items. Additionally, we should consider how to support the questionnaire design process when appropriate constructs and measurement items are not available. Furthermore, our system currently supports only construct selection and development of measurement items. In the future, it would be beneficial to explore methods to validate the reliability of measurement items and statistical analysis techniques, and ways to support evaluation planning using the custom constructs and measurement items. Finally, we should improve the rigor and reliability of the designed constructs and measurement items. Currently, we primarily rely on previous research to ensure reliability and rigor, but better methods are needed. For instance, crowdsourcing approaches could be used to improve the reliability of measurement items based on feedback.

5. Conclusion

In this paper, we present UX Remix, a system that supports the measurement item design process using LLMs. We first collected 697 constructs from the previous literature and extracted relevant information using LLMs. Then, we pre-processed the measurement items for each construct and stored them in a vector database. UX Remix uses data to support the design process for custom constructs and measurement items. UX Remix first receives a project description that includes details on the system description, the purpose of the evaluation, and the hypothesis. Then, UX Remix retrieves the 10 most relevant constructs from the vector database based on the project description and recommends them. Afterward, UX Remix refines the construct and measurement items according to the project description and the selected constructs. Finally, UX Remix suggests appropriate measurement items aligned with the project context. Through

the process, we expect that researchers could design custom constructs and measurement items based on pre-defined measurement items that fit to their research contexts.

Declaration on Generative AI

During the preparation of this work, the authors used OpenAI ChatGPT *GPT-4o* for: grammar and spelling check, paraphrasing and writing style polishing. After using the tool, the authors reviewed and edited the content as needed and take full responsibility for the publication's content.

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A. Prompts

A.1. Design GPT for Data Extraction

Below is the description and instructions of the GPT to extract construct and information from collected papers.

Description

- Based on the given paper and construct, the GPT returns the construct definition, construct usage, point and type of measurement items, measurement items, number of items, title of the paper, and an APA reference

Instructions

- This GPT provides the construct definition, construct usage, point and type of measurement items, measurement items, number of items, title of the paper, and an APA reference based on the given paper and construct. The output should follow the format below.
 - **Construct:** [Construct Name]
 - **Definition:** [Definition of the construct, *Construct Name* is ...]

- **Usage:** The paper uses the [X] to evaluate users' [Y] regarding [Z technology]. The paper found [findings related to Y]. [18]
 - **Point and Type of Measurement Items:** [7]-point Likert Type, [6]-point Semantic Type, ...
 - **Measurement Items:** [1. ... | 2. ... | ...]
 - **Number of Measurement Items:** [The number of measurement items specified in the paper.]
 - **Title:** [Title of the paper]
 - **APA reference:** [APA format of the paper]
-

A.2. Prompts for Custom Construct Generation

Below is a prompt for generating a custom construct. The texts inside curly braces (i.e. “ {} ”) indicate variable names.

Role: system

You are an expert in HCI research methodology. Please customize the construct name, definition, point, and type based on the given construct names, definitions, points, and types. Please consider the given system description, evaluation purpose, and hypothesis. You must respond using the defined JSON schema.

Role: user

System description: {System description}

Evaluation purpose: {Evaluation purpose}

Hypothesis: Effects of {Interactive feature} to {core user experience}

Selected constructs name: {List of selected constructs' name}

Selected constructs definition: {List of selected constructs' definition}

Selected constructs point (scale): {List of selected constructs' point}

Selected constructs type (scale type): {List of selected constructs' scale type}

Please customize the construct name, definition, point, and type based on the given construct names, definitions, points, and types.

Please consider the given system description, evaluation purpose, and hypothesis.

Response format:

1. Custom construct name: (string of custom construct name)
 2. Custom construct definition: (string of custom construct definition)
 3. Custom construct point (scale): (integer of custom construct point)
 4. Custom construct type (scale type): (string of custom construct type)
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A.3. Prompts for Refinement of Measurement Items

Below is a prompt for refinement of measurement items. The texts inside curly braces (i.e. “ {} ”) indicate variable names.

Role: system

You are an expert in HCI research methodology. Please refine the measurement items to make them based on given context. You must respond using the defined JSON schema.

Role: user

System description: {System description}

Evaluation purpose: {Evaluation purpose}

Interactive feature: {Interactive feature}

Core user experience: {core user experience}

Hypothesis: Effects of {Interactive feature} to {Core user experience}

Construct Name: {Custom construct name}

Construct Definition: {Custom construct definition}

Available measurement items: {Measurement items from selected constructs}

Based on the context, please modify the measurement items to be more natural and clear. Please follow below rules.

1. Please change the terms like [Evaluation Target] to appropriate words in all measurement items. After that, if the measurement item sentence is awkward, please modify it to be appropriate.
2. As you know, the construct name and core user experience might not be evaluation target.
3. If you think that the measurement item is a reverse-coded item, Please add (R, reverse) after the reverse-coded item.
4. Please exclude any words in the measurement items that do not fit (e.g. term like “educational content” could be excluded if the evaluation purpose or product explanation is not for education).
5. However, please maintain the original meaning and expression as much as possible, and only remove unnecessary or inappropriate parts.
6. Furthermore, please maintain the format of the measurement items.

For instance, “I am satisfied with visiting this website.” to “I am satisfied with using this app,” “I believe in the educational capabilities of avatar.” to “I believe in the capabilities of avatar.”

A.4. Prompts for Classification of Measurement Items

Below is a prompt for classification of measurement items. The texts inside curly braces (i.e. “{ }”) indicate variable names.

Role: system

You are an expert in HCI research methodology. Please select the most appropriate measurement items and the inappropriate measurement items based on the evaluation purpose and hypothesis. You must respond using the defined JSON schema.

Role: user

System description: {System description}

Evaluation purpose: {Evaluation purpose}

Interactive feature: {Interactive feature}

Core user experience: {Core user experience}

Hypothesis: Effects of {Interactive feature} to {Core user experience}

Construct Name: {Custom construct name}

Construct Definition: {Custom construct definition}

Available measurement items: {Refined measurement items}

Please select the most appropriate measurement items and the inappropriate measurement items based on the evaluation purpose and hypothesis.

Please maintain the format of the measurement items.

Please respond in sentences rather than numbers.

Response format:

1. Appropriate items: (list all appropriate items in one line, separated by |)
 2. Inappropriate items: (list all inappropriate items in one line, separated by |)
 3. Rationale for selection: (string of rationale for selection)
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