Measuring Engagement Through Remote Interactions of Customers: Introducing METRIC

Jinan Y. Azem
Qatar Computing Research Institute, Hamad Bin Khalifa University
Doha, Qatar
jazem@hbku.edu.qa

Joni Salminen
University of Vaasa
Vaasa, Finland
jonisalm@uwasa.fi

Soon-gyo Jung
Qatar Computing Research Institute, Hamad Bin Khalifa University
Doha, Qatar
sjung@hbku.edu.qa

Bernard J. Jansen
Qatar Computing Research Institute, Hamad Bin Khalifa University
Doha, Qatar
jjansen@acm.org

2023 International Symposium on Networks, Computers and Communications (ISNCC) | 979-8-3503-3559-0/23/$31.00 ©2023 IEEE | DOI: 10.1109/ISNCC58260.2023.10323669

***Abstract*—In this article, we present METRIC. Measuring Engagement Through Remote Interactions of Customers (METRIC) (https://metric.qcri.org/) is a tool for collecting, measuring, analyzing, and reporting the engagement of online systems through actual interactions of customers or users, either remote or in the lab. METRIC enables system stakeholders to enhance their understanding of their audience, customer, or users' actual behavior on pages, images, videos, interfaces, and online systems, including the gaze and interaction with sub-elements on a page within a system or comparisons via A/B testing. Along with eye-tracking devices, METRIC uses a webcam-based eye-tracking JavaScript library for the ability to monitor the users' real visual attention during interaction with the online system. METRIC provides sophisticated reporting features throughout the collecting, measuring, and analyzing process. METRIC can also be deployed in user experiments toward the design of better cooperation technologies, primarily due to its online nature.**

Keywords—user, user testing, HCI, user studies

I. INTRODUCTION

User studies are valuable for gaining knowledge and insights into the interaction among systems and users, including audiences of major online platforms, customer service by online stores, and users of online systems that carry out tasks alone or collaboratively. Usability testing tools, such as UserZoom, UsabilityHub, and User Testing, allow researchers to check the usability of digital interfaces or products with users using screen recording and eye tracking methods. A/B testing tools, such as Optimizely and Crazy Egg, allow researchers to test different variations of digital interfaces or products with users and gather data and insights about user preferences and behavior. Eye tracking systems like Tobii Pro and EyeLink allow researchers to track where users look on a screen or in a physical space, providing insights into visual attention and engagement. Analytics and tracking tools, like Google Analytics and Matomo, provide insights into user behavior and engagement with digital products or content.

Overall, user study systems can broaden the participation base, explicitly enhancing the ability to test designs and features. Prior research shows that empirical methods and data sources can complement each other in improving user understanding [6]. Therefore, user study systems have become increasingly crucial for businesses and organizations seeking to understand their audiences, customers, and users, including how they collaborate.

User study systems are tools and methods researchers use to conduct studies on user behavior and preferences, both in the lab (on-site or remote) and in the field (i.e., the natural environment of the sample population) [17]. There are a variety of user study systems and approaches [28]. Surveys and questionnaire tools like Qualtrics and Google Forms allow researchers to gather quantitative and qualitative data about user preferences, attitudes, and experiences. Survey tools are evolving and adapting to societal changes in how people communicate and in response to technological developments that make new ways of communicating and collecting survey data possible [5].

Various visual analytics and reports tools have emerged to help organizations analyze their data effectively. Visual analytics provides stakeholders with practical tools to analyze and understand large datasets for actionable conclusions[12] Finally, given the worldwide user base of many systems, a user study system must work remotely while offering a range of data collection options[10]. Without this remote capability and sole reliance on on-site lab experiments, user study analytics systems rely on data collected from a specific subset of users, which may not represent the broader user population. This can lead to sample bias, where the insights gleaned from the data do not accurately reflect the preferences and behaviors of the broader user base[7].

While user study analytics systems are valuable tools for understanding user behavior and preferences, these systems often have shortcomings [2]. First, user study analytics systems are typically designed to capture specific metrics and behaviors, such as clicks, page views, and time spent on a site. However, these metrics may not provide a complete picture of user behavior or preferences or capture more nuanced aspects of user experience, such as emotional responses, motivation, or cognitive processes. Second, user study analytics systems may not capture all relevant data points or behaviors, mainly if users engage with a product or service across multiple devices or platforms. Third, the data collected through user study analytics systems can be complex and difficult to interpret, requiring

specialized knowledge and expertise. This can pose a challenge for organizations that lack the resources or expertise to analyze the data effectively.

Overall, while user study analytics systems can provide valuable insights into user behavior and preferences, it is essential to be aware of these shortcomings and to use these tools in conjunction with other research methods (e.g., qualitative interviews or think-aloud) to develop a comprehensive understanding of users and their needs. To assist researchers in this endeavor, the current research discusses a novel user study system for online user study needs: METRIC (Measuring Engagement Through Remote Interactions of Customers).

METRIC is a user study and data visualization tool that can bridge multiple aspects of a user study by measuring direct user-computer interaction aspects (mouse clicks, eye hits, eye gaze, mouse movements, etc.), as well as integrating pre- and post-study surveys. Additionally, METRIC facilitates system evaluation processes with customizable options, and it meets research needs in a low-cost, flexible system capable of both remote and on-site studies. In this work, we present METRIC's capabilities and the advantages it offers researchers for a better audience, customer, and user understanding, both when conducting in-person studies and online user research. We address three relevant questions: (1) What is METRIC? (2) Why is METRIC needed? (3) How does METRIC work? Our treatise of these questions is exploratory, as the scope of this work is to describe the current state of the system and its prospects.

The following sections discuss METRIC, including the system architecture, metrics, collected, and report features. We provide detailed examples of the various types of user studies (e.g., webpages, interfaces, images, and videos) METRIC affords. We end with the benefits of METRIC for audience, customer, and user understanding.

II. Related work

Understanding the user has been an area of interest with the rise of online systems, user interfaces, and even marketing/digital marketing[5]. One of the ways to understand users is through user studies and user tracking. Hence, user study tools are being developed to meet this purpose. A system for conducting user studies typically includes a set of processes, tools, and techniques for gathering data and insights about user behavior and preferences. A user study system should generally support the major components of standard user studies.

A. User Studies

A robust user study and the system supporting it [20], includes participant recruitment, data collection, data analysis, reporting, and iteration (i.e., ongoing iteration and refinement of the research process based on the insights gained from each study, to improve the accuracy and usefulness of the research findings). A key component, currently lacking in many user study systems, is robust data collection. There is often the need for user studies to collect various data from different sources for *data triangulation*[7]. For example, we cannot access the entire user population for each user study, so we take a sample. The sample means and proportions estimate the values we want in the sample population. Even the best estimate from a sample will never be exactly right, so to know how precise our estimates are, we use confidence intervals and margin of error [22]. A user study system includes tools and techniques for collecting data, such as online surveys, interviews, or usability testing, gathering qualitative and quantitative data that can be analyzed to gain insights into user behavior and preferences. Such systems facilitate data collection, analysis, and reporting in a way that provides meaningful insights into user behavior and preferences that can be used to inform the design and development of products, services, and marketing [23].

We discuss two general approaches to categorizing user-study tools, on-site and remote, in the following sections.

B. On-site User Studies and Systems

On-site user studies typically involve conducting research in a physical location, such as a retail store or office, and involve various techniques for collecting data about user behavior and preferences[11,15,27]. Some examples of user study approaches that are commonly used in on-site user studies include observation (e.g., video recordings, field notes, or checklists) [14], eye tracking, biometric sensors, surveys and questionnaires [1], usability testing (i.e., screen capture software), and interactive prototypes (i.e., digital mock-ups of products or services). On-site user studies require a combination of tools and techniques tailored to the specific research objectives and user population being studied. By using many user study systems, researchers can gain a more comprehensive understanding of user behavior and preferences, and use these insights to inform the design and development of products and services that better meet user needs.

C. Remote User Studies and Systems

Remote user studies involve conducting research with participants who are in different geographic locations from the researchers, typically using digital tools and technologies [25]. Some examples of user study approaches that are commonly used for remote user studies include online surveys and questionnaires, remote usability testing platforms, video interviews, analytics and tracking, and A/B testing tools. Performing remote user studies can involve micro-task markets, such as the Amazon Mechanical Turk, where researchers can use crowdworkers to perform on-demand tasks [13]; crowdsourcing studies need careful design [21]. Overall, remote user studies require a combination of tools and techniques that are tailored to the specific research objectives and user population being studied.

D. Prior Research on User Study System Development

There have been prior efforts to develop user study systems, or, at least, components that could be integrated into a complete user study system. For example, *Gazetracker* facilitates the analysis of a test 'subject's eye movements and pupil response to visual stimuli, such as still images or dynamic software applications that the test subject interacts with Internet Explorer [16] *WiIRE* is a remote architecture for conducting information searching experiments [25]. *WebGazer* [18,19] is an online eye tracker that uses webcams present on laptops and other devices to infer the eye movements and gaze of web visitors on a page in real-time. *Omicron* is an Android app that is used to collect

mobile query logs and perform user studies on mobile devices [4]. Another tool is the *ARgus Designer System*, whose

TABLE I. POTENTIAL USER PERSONAS OF METRIC WITH DESCRIPTIONS

METRIC System Stakeholder	***Use Case Scenario***	***Why do they need METRIC***
Product Manager	Improving a current product (website)	They can use METRIC to test what is working and what is not through behavioral and attitudinal data. The product manager can conduct a study of how users interact with his/her website. The PM can create tasks for the participants and observe how they complete them through behavioral metrics such as clicks, scrolls, and eye movements. Additionally, they can get attitudinal data by asking the participants a few questions about their experience and opinions of the website. The integrated survey allows the PM to get direct insights from the users about what they desire, what problems they face, and what functionalities would be valuable to them.
UX/UI Designer	A UX/UI designer is testing designs (initial phase of a product; not released yet)	UX/UI design is an iterative process where feedback and testing are needed between each iteration. With METRIC, a UX designer can test their designs. Metric covers the two areas of interest for a designer - the behavioral data, or directly observing the user and their actions, and the attitudinal data, which asks users to self-report their opinions via the questionnaire. METRIC gives the designer access to both data types together in one study.
Marketer	A marketer has a campaign coming up, and he created two posters. Both of them fit with marketing principles, but he is not sure which of the posters is most likely to catch the customer's attention and what components on the poster will catch the customers' attention first.	METRIC can help the marketer observe where the customer will look first (utilizing the eye tracking feature) and check where they looked and what they looked at the most. The marketer can also wrap up the user testing by asking questions via the questionnaire to get attitudinal data and allow the customer to give further feedback and ideas before the campaign launches.
Researcher	A researcher wants to explore design principles and techniques that optimize usability, efficiency, and website engagement, so he performs a user study on METRIC.	The researcher puts multiple main page designs for the same website, and he observes how the participants interact with it. He explores the participants' behaviors using eye tracking, mouse hits, and mouse clicks. He then ends each study with a survey to get more attitudinal insights from the participants, giving him more information about usability and engagement.

objective is to conduct user studies for testing the usability and user experience of AR/MR applications [24]. A Robot Management System (RMS) is a user study tool for testing Human-Robot Interactions [26]. However, these tools are limited in their data collection (i.e., eye tracking only), are tailored for specific devices (i.e., mobile), or limited domains (i.e., robotics).

METRIC addresses these limitations by being a user study tool for various online systems, images, interfaces, or videos. Additionally, METRIC affords data collection along multiple fronts (i.e., eye, mouse, click path, and surveys), and the system is functional both in the lab and remotely, including crowdworkers. It applies to a wide range of domains. As such, METRIC is a robust, fully functional user study system.

III. SYSTEM OVERVIEW

A. What is METRIC?

The METRIC system is a user study tool to measure engagement through real interactions of users. METRIC can serve different user types (see Table I).

B. Why is METRIC needed?

METRIC enables system stakeholders to enhance their understanding of their audience, customers, or users via actual behavior on particular components of online systems, including the focus and interaction with sub-elements on a page within that system. METRIC is developed for researchers (e.g., those working in HCI, UX, CSCW, or marketing) to measure direct interactions between the user and the website. METRIC measures the following aspects:

Eye Hits: Where did the customer look on the page and in what order?

Eyegaze: At what elements did the customer gaze?

Mouseclick: Where the user clicked, and how many times?

Mousehits: How many times did the user move the mouse? and in what order?

Mouseover: What elements did the customer mouse hover over?

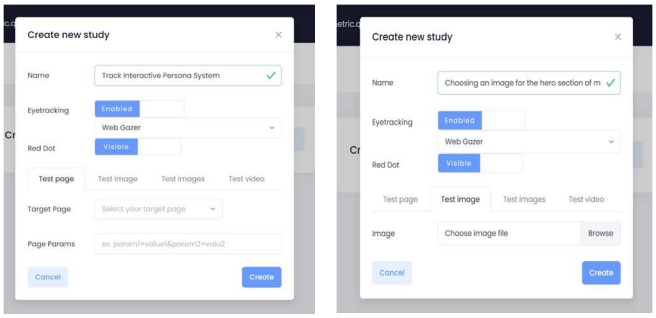
Page: How many times did a user visit? How long did they stay?

Questionnaire: What are the affective, subjective, and cognitive responses?

C. How does METRIC work?

METRIC provides the manageability of user studies for the stakeholders' online systems via simple yet nuanced and sophisticated methods. METRIC users can create a user study for a target page, or other artifacts, including images and videos, on an online system (see Fig. 1).

To create a user study, the user needs to simply click a 'Create New Study' button found in the Navigation Bar of the website. A pop-up appears where the user needs to add information about their study, including the name of the study, as well as switch on the eye-tracking and web gaze based on their study's need.



(a) (b)

Fig. 1. (a) Once the users click on the button, they can start by choosing a name for their study, enabling eye tracking and eye-gazing tools, and uploading the targeted page they want to test. (b) The user can also upload an image and test it (e.g., testing different advertisements or layouts).

Lastly, the user needs to add the link to a target page of a website or an image or video (see Fig. 1). Once the end users are done with this step, and choose their website, image, or video, the user study will be created. Afterward, the user can turn their user study live by switching on the toggle (see Fig. 2). When the toggle is switched on, the user study link can be sent to the participants, and they can perform the user study. When the toggle is switched off, participants cannot perform the user study.

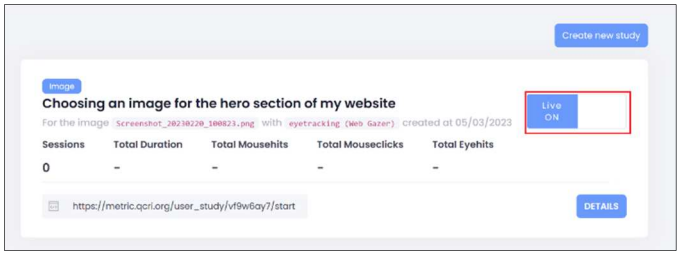


Fig. 2. The user study is created, and METRIC users use the toggle switch to switch on their study.

Finally, the user can now visit their user study page to view details and add customization to the study (see Fig. 3 and 4).

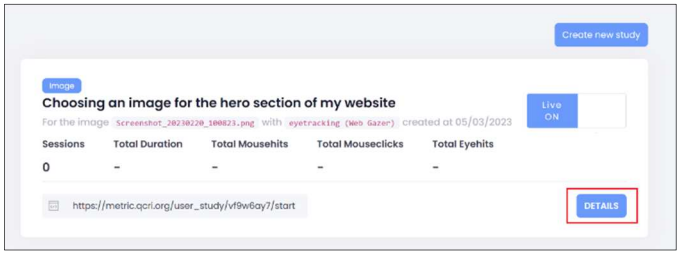


Fig. 3. Users can view and define the details of their study by clicking on the 'Details' button shown in the figure.

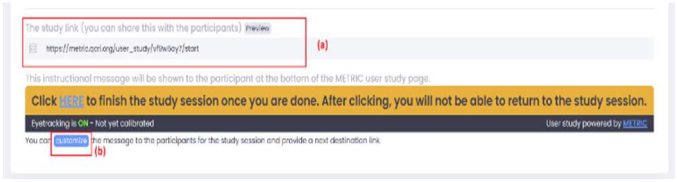


Fig. 4. Once the user clicks on the Details button (see Figure 3), (a) they will get a link that can be copied and sent to participants. (b) They can click on the customize button to define the details of their study (see Figure 5).

The user can customize their introductory and conclusion messages and add a survey link as a post-study follow-up (see Fig. 5), including the use of major survey platforms such as Google Forms or Qualtrics. The survey option is of great importance for the end user to get more supporting information from survey participants, both quantitative and qualitative.

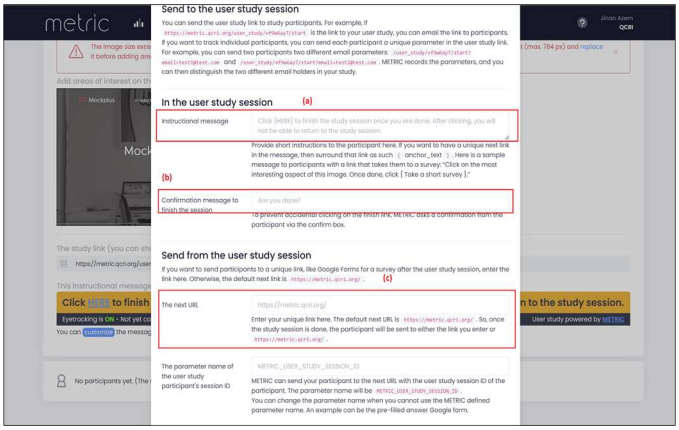


Fig. 5. The users can customize their study with (a) an introduction message for the participants, (b) a message to finish the session, and (c) a link input for any follow-up survey links. The user study will be ready for participants; the user can send the study link to participants.

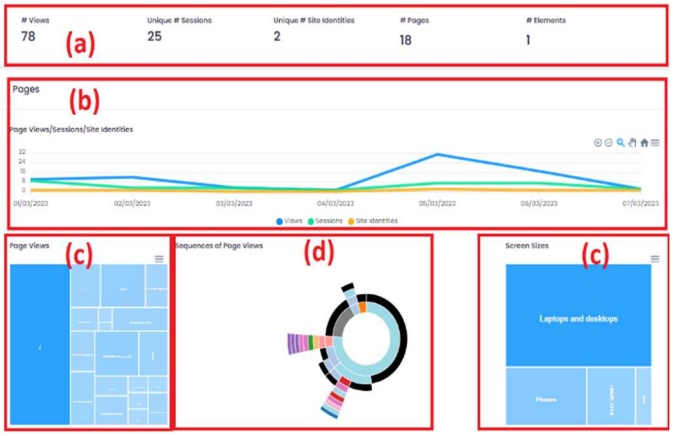


Fig. 6. METRIC has a report feature that displays the following information to the creators of the study: (a) Metrics over time, (b) Page views/sessions/site identities over time, (c) two tree diagrams showing page views and screen sizes, and (d) a sequence chart of page views, which is interactive.

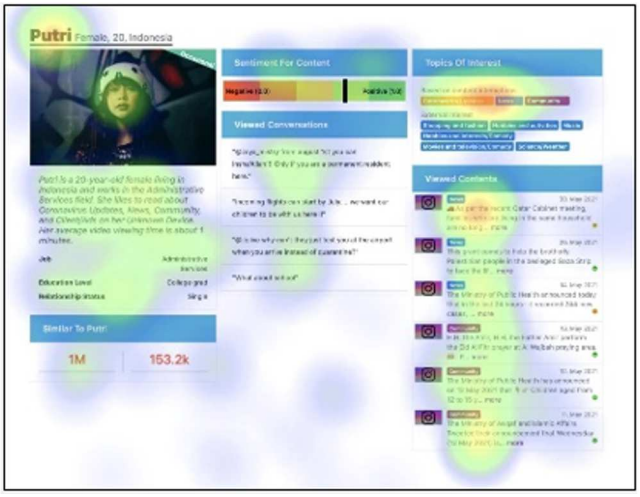


Fig. 7. Example of a heatmap generated using METRIC's eye-tracking capabilities. Heatmaps can be generated from both webcam eye tracking (remote user studies) and physical eye tracking (currently supporting the PupilCore Core tracker).

As shown in Fig. 1-7, the METRIC user study process is simple, facilitating a quick, straightforward, and inexpensive user study. For demonstration purposes, we also tracked an interactive persona system on METRIC [8,9], of which the result was a heatmap generated using METRIC's eye-tracking capabilities (see Fig. 7).

D. What differentiates METRIC?

There, of course, are existing user study tools. To highlight METRIC's uniqueness relative to other existing systems, we compared METRIC to several existing user study systems (see Table 2). From the comparative analysis, METRIC demonstrated at least two unique features: integrated *eye tracking* and *surveys*. Although eye-tracking systems and survey platforms exist, they are not fully integrated with other features such as METRIC.

With integrated eye tracking, clicks, mouse moves, and scroll data, METRIC records behavioral data, which directly observes how the users behave with the system. METRIC can provide attitudinal data with the survey, and participants perform the study. METRIC will provide reports based on participants' responses, including the self-reporting of users' opinions. Rather than an inherent survey feature, METRIC employs industry-standard survey platforms, such as Google Forms, Survey Monkey, and Qualtrics. This integration of eye tracking and survey collection makes METRIC a tool that provides a well-rounded user set of data, allowing the researcher to combine the insights and make informed decisions about their product, advertisement, etc.

IV. System Evaluation

In order to evaluate METRIC, we interviewed a researcher who had used the system for a user study. We did the evaluation using the SUS (System Usability Scale)[3]. We gave the user the following 10 questions and asked him to answer on a five-point Likert Scale of 'Strongly Disagree' to 'Strongly Agree', as well as asked him to provide us with open-ended responses to those statements.

Table 3 shows the 10 statements that were given to the user, along with the user's Likert scale responses.

The main points driven by the user's interview responses were the following:

- The user appreciates that METRIC is easy to use and offers a wide range of functionalities, including the ability to use both video and image materials for user study participants to evaluate, track mouse clicks, and use two different eye-tracking systems. He found that using Areas of Interest (AoIs) helped point out where his participants looked and which parts they looked at before clicking. He found that the data can be exported easily in Excel CSV format, which he said is convenient.

TABLE II. Comparing METRIC to other user study systems

	Remote	***Clicks***	***Scrolls***	***Mouse moves***	***Heatmaps***	***Eye tracking***	***Integrated surveys***
METRIC	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Crazy Egg	Yes	Yes	Yes	No	Yes	No	No
Hotjar	Yes	Yes	Yes	Yes	Yes	No	No
UXTweak	Yes	Yes	Yes	Yes	Yes	No	Yes
Lucky Orange	Yes	Yes	Yes	Yes	Yes	No	No
UserZoom	Yes	Yes	No	No	Yes	No	Yes
UsabilityHub	Yes	Yes	No	No	Yes	No	No
Optimizely	Yes	No	No	No	Yes	No	No
Matomo	Yes	Yes	Yes	Yes	Yes	No	No

TABLE III. SINGLE-USER EVALUATION RESULTS

Statement	Response
I think that I would like to use this website frequently.	Strongly agree
I found this website unnecessarily complex.	Disagree
I thought this website was easy to use.	Agree
I think that I would need assistance to be able to use this website.	Disagree
I found the various functions on this website were well integrated.	Agree
I thought there was too much inconsistency on this website.	Disagree
I would imagine that most people would learn to use this website very quickly.	Agree
I found this website very cumbersome/awkward to use.	Strongly Disagree
I felt very confident using this website.	Agree
I felt very confident using this website.	Strongly disagree

- The user found METRIC to be user-friendly overall. However, the user suggests a feature for easier creation of multiple user studies with similar settings, which could enhance scalability. As he said: "If there was a feature where I could create like 30 user studies with the same settings but just change the image or video, it would make the system even more scalable."
- The user found it easy to locate buttons and features within the system.
- While the user, personally tech-savvy, did not require additional assistance, he suggests the inclusion of a guiding feature (similar to the old Word Clipper, he suggests) that provides pop-up explanations when hovering over features to aid less experienced users.
- The user found the features to be well integrated but suggested clearer explanations for how different integrations work for first-time users, as he put it: "Like when using eye-tracking, for a first-time user it might not be clear how it works or what kind of data does the system output."
- The user thinks that most people would learn to use this website very quickly in terms of usability, However, in terms of understanding METRIC's potential, the user thinks that understanding its full potential may require additional guidance.
- The user notes that the website's format and functionality resemble other websites, making it easier to navigate. They reiterate the suggestion for a popup guide to help users understand different functionalities.

In summary, the user found METRIC to be highly usable and intuitive to use. He found the functionalities such as eye tracking, AoIs, and the capability to upload both images and videos to be quite helpful for him as a researcher. However, he had some suggestions that could guide first-time users better and make METRIC's potential clear.

V. CONCLUSION AND FUTURE WORK

User study tools are essential for businesses and organizations to gain insights about their audiences, customers, and users in individual and collaborative tasks. Those tools aid researchers, system developers, designers, and marketers in gathering data about their users' interactions with their systems, their preferences, and their pain points. This data is fundamental to making informed decisions about the design and development of their products, services, or marketing strategies.

Many user study tools have limitations, such as inadequate scope, incomplete data, interpretation challenges, and limited capability for remote studies. We introduced the METRIC user study tool to address some of these limitations. METRIC combines beneficial aspects from a variety of user study approaches. It is a usability testing tool using eye tracking, page flow, eye gaze, and mouse movements. METRIC also has the feature of integrated surveys as both a pre- and post-study collection. METRIC also provides analytics information.

Overall, METRIC combines helpful elements of user study types. METRIC is already deployed and used in various studies. Future work includes improving the accuracy of the remote eye tracking tool, although indeed deployed and functional. The addition of more user study tool features, such as audio recording and transcription, is also possible. We are also looking into adding active user interface testing features to METRIC, including experiments in collaborative work settings. Contributions in this space can result in exciting empirical findings on how users interact with systems.

REFERENCES

[1] Aisha Ahmed AlArfaj and Ellis Solaima. 2022. Comparing different qualitative methods to understand user experience in Saudi Arabia. In Proceedings of 20th European Conference on Computer-Supported Cooperative Work, European Society for Socially Embedded Technologies (EUSSET).

[2] Regina Bernhaupt, Kristijan Mihalic, and Marianna Obrist. 2008. Usability evaluation methods for mobile applications. In Handbook of research on user interface design and evaluation for mobile technology. IGI Global, 745–758.

[3] John Brooke. 1995. SUS: A quick and dirty usability scale. Usability Eval. Ind. 189, (November 1995).

[4] Luca Costa, Mohammad Aliannejadi, and Fabio Crestani. 2020. A Tool for Conducting User Studies on Mobile Devices. In Proceedings of the 2020 Conference on Human Information Interaction and Retrieval, ACM, Vancouver BC Canada, 462–466. DOI:https://doi.org/10.1145/3343413.3377985

[5] M. P. Couper. 2011. The Future of Modes of Data Collection. Public Opinion Quarterly 75, 5 (December 2011), 889–908. DOI:https://doi.org/10.1093/poq/nfr046

[6] Armin Falk and James J. Heckman. 2009. Lab Experiments Are a Major Source of Knowledge in the Social Sciences. Science 326, 5952 (October 2009), 535–538. DOI:https://doi.org/10.1126/science.1168244

[7] Bernard J. Jansen, Joni Salminen, Soon-gyo Jung, and Hind Almerekhi. 2022. The illusion of data validity: Why numbers about people are likely wrong. Data and Information Management 6, 4 (October 2022), 100020. DOI:https://doi.org/10.1016/j.dim.2022.100020

[8] Soon-Gyo Jung, Joni Salminen, and Bernard Jansen. 2021. Persona Analytics: Implementing Mouse-Tracking for an Interactive Persona System. In Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems (CHI EA '21), Association for Computing Machinery, New York, NY, USA, 1–8. DOI:https://doi.org/10.1145/3411763.3451773

[9] Soon-Gyo Jung, Joni Salminen, and Bernard Jansen. 2021. Implementing Eye-Tracking for Persona Analytics. In ACM Symposium on Eye Tracking Research and Applications (ETRA '21 Adjunct), Association for Computing Machinery, New York, NY, USA, 1–4. DOI:https://doi.org/10.1145/3450341.3458765

[10] Anu Kankainen, Kirsikka Vaajakallio, Vesa Kantola, and Tuuli Mattelmäki. 2012. Storytelling Group – a co-design method for service design. Behaviour & Information Technology 31, 3 (March 2012), 221–230. DOI:https://doi.org/10.1080/0144929X.2011.563794

[11] Christos Katsanos, Nikolaos Tselios, and Nikolaos Avouris. 2010. Evaluating website navigability: validation of a tool-based approach through two eye-tracking user studies. New review of Hypermedia and Multimedia 16, 1–2 (2010), 195–214.

[12] Daniel Keim. 2012. Solving Problems with Visual Analytics: Challenges and Applications. In Machine Learning and Knowledge Discovery in Databases, Peter A. Flach, Tijl De Bie and Nello Cristianini (eds.). Springer Berlin Heidelberg, Berlin, Heidelberg, 5–6. DOI:https://doi.org/10.1007/978-3-642-33460-3_4

[13] Aniket Kittur, Ed H. Chi, and Bongwon Suh. 2008. Crowdsourcing user studies with Mechanical Turk. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '08), Association for Computing Machinery, New York, NY, USA, 453–456. DOI:https://doi.org/10.1145/1357054.1357127

[14] Sami Koivunen, Ekaterina Olshannikova, and Thomas Olsson. 2021. Understanding matchmakers' experiences, principles and practices of assembling innovation teams. Computer Supported Cooperative Work (CSCW) 30, (2021), 589–616.

[15] Sari Kujala. 2002. User studies: A practical approach to user involvement for gathering user needs and requirements. Helsinki University of Technology.

[16] Chris Lankford. 2000. Gazetracker: software designed to facilitate eye movement analysis. In Proceedings of the 2000 symposium on Eye tracking research & applications (ETRA '00), Association for Computing Machinery, New York, NY, USA, 51–55. DOI:https://doi.org/10.1145/355017.355025

[17] Steven D. Levitt and John A. List. 2007. What do laboratory experiments measuring social preferences reveal about the real world? Journal of Economic perspectives 21, 2 (2007), 153–174.

[18] Alexandra Papoutsaki, Aaron Gokaslan, James Tompkin, Yuze He, and Jeff Huang. 2018. The eye of the typer: a benchmark and analysis of gaze behavior during typing. In Proceedings of the 2018 ACM Symposium on Eye Tracking Research & Applications, ACM, Warsaw Poland, 1–9. DOI:https://doi.org/10.1145/3204493.3204552

[19] Alexandra Papoutsaki, Patsorn Sangkloy, James Laskey, Nediyana Daskalova, Jeff Huang, and James Hays. 2016. WebGazer: Scalable Webcam Eye Tracking Using User Interactions. Retrieved March 6, 2023 from https://www.semanticscholar.org/paper/WebGazer%3A-Scalable-Webcam-Eye-Tracking-Using-User-Papoutsaki-Sangkloy/73fc8e9b1faf45855cceee197f094ca3c05afe1c

[20] Kristina Ricks and Beverly A. Arnoldy. 2002. How to conduct your own usability study. In Proceedings. IEEE International Professional Communication Conference, IEEE, 115–126.

[21] Joni Salminen, Ahmed Mohamed Kamel, Soon-Gyo Jung, and Bernard Jansen. 2021. The Problem of Majority Voting in Crowdsourcing with Binary Classes. In Proceedings of 19th European Conference on Computer-Supported Cooperative Work, European Society for Socially Embedded Technologies (EUSSET).

[22] Jeff Sauro and James R. Lewis. 2012. Chapter 3 - How Precise Are Our Estimates? Confidence Intervals. In Quantifying the User Experience, Jeff Sauro and James R. Lewis (eds.). Morgan Kaufmann, Boston, 19–39. DOI:https://doi.org/10.1016/B978-0-12-384968-7.00003-5

[23] Jeff Sauro and James R. Lewis. 2016. Quantifying the user experience: Practical statistics for user research. Morgan Kaufmann.

[24] Eleni Stefanidi, Asterios Leonidis, Maria Korozi, and George Papagiannakis. 2022. The ARgus Designer: Supporting experts while conducting user studies of AR/MR applications. DOI:https://doi.org/10.1109/ISMAR-Adjunct57072.2022.00190

[25] Elaine G. Toms, Luanne Freund, and Cara Li. 2004. WiIRE: the Web interactive information retrieval experimentation system prototype. Information Processing & Management 40, 4 (2004), 655–675.

[26] Russell Toris, David Kent, and Sonia Chernova. 2014. The Robot Management System: A Framework for Conducting Human-Robot Interaction Studies Through Crowdsourcing. Journal of Human-Robot Interaction 3, 2 (June 2014), 25. DOI:https://doi.org/10.5898/JHRI/3.2.Toris

[27] Melanie Tory. 2013. User studies in visualization: A reflection on methods. In Handbook of Human Centric Visualization. Springer, 411–426.

[28] Tom D. Wilson. 1981. On user studies and information needs. Journal of documentation 37, 1 (1981), 3–15.