



User Perceptions of CAPTCHAs: University vs. Internet Users

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Abstract. We surveyed over 250 participants from a university and Amazon Mechanical Turk to understand user perceptions of CAPTCHA security and usability. Users reported struggling with CAPTCHA challenges due to increasing difficulty, leading to frustration and a negative experience. Concerns about reliability and security were also noted. Our findings offer valuable insights for developing more secure and user-friendly CAPTCHA technologies.

Keywords: CAPTCHA · Authentication · Usability

1 Introduction

CAPTCHA is a challenge-response test to distinguish human users from bots, preventing abuse like false form submissions, fraudulent purchases, spam emails, and fake registrations. Since the late 1990s, CAPTCHAs have evolved into various forms, including text, image, audio, and video. However, as they have become more common, security concerns have arisen. An ideal CAPTCHA should balance security and usability. To defend against attacks, CAPTCHAs often introduce distortion and noise, making them harder for users to solve. Text-based CAPTCHAs often contain scattered lines, dots, and distorted characters that require extra user effort. These distortions can be especially unfriendly to users whose native language does not use the Latin alphabet [7]. Image-based CAPTCHAs present accessibility challenges for users with visual impairments or color blindness [7]. Audio and video-based CAPTCHAs face issues with large file sizes and limited user comprehension time [1, 6].

Creating a secure yet user-friendly CAPTCHA system is challenging. We surveyed over 250 participants, including computer science students and Amazon Mechanical Turk users. We found that illegible texts/images and unclear instructions were the main reasons for failing CAPTCHAs. Human errors like lack of time and inattention also contributed to failures. Users often abandoned webpages if they could not solve CAPTCHAs on the first attempt, causing decreased traffic. The study showed that users view CAPTCHAs as a necessary burden. We also examined differences between the two user groups and explored factors contributing to these variances.

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Our work explores user perspectives on CAPTCHA security and usability, with a focus on the latter. We integrate usability issues from Yan et al.'s work [7]. Unlike prior studies focusing on specific CAPTCHA types [3–7], our study covers all types. Similar to Fidas et al.'s survey [2], we examine security-usability trade-offs, attempts needed to solve CAPTCHAs, and language influences. However, we also investigate how user views have evolved over the past decade and compare opinions from two distinct participant groups. Conversely, Fidas et al.'s study did not specify their participant sources.

2 Methodology

We conducted an online survey to understand how users perceive and adopt CAPTCHA mechanisms. The study was reviewed and approved by our institution's Institutional Review Board.

2.1 Recruitment

We recruited participants from Amazon Mechanical Turk (MTurk) and university students majoring in Computer Science. We selected MTurk candidates with a Human Intelligence Task (HIT) rate of over 90% and more than 50 approved HITs, paying each \$1 for the 5-minute survey. Within 30 min, we received 150 responses, primarily from the U.S. University users were upper-division computer science students at a public university in the U.S. with a technical background.

2.2 Study Design

We used Qualtrics for an anonymous survey, providing unique codes to prevent multiple submissions. The survey included seven demographic and eligibility questions, followed by 16 questions on CAPTCHA perceptions. Participants rated different CAPTCHA types on a five-point Likert scale and provided feedback regarding non-English CAPTCHAs. Usability questions covered experiences on small devices (phones or tablets), considering screen size, orientation, network bandwidth, and processor speed. We asked if they generally solved CAPTCHAs on the first attempt and, if not, the reasons behind their difficulties. We explored user frustration and whether they had abandoned a website due to CAPTCHAs. We assessed security with three questions on user views of CAPTCHA security and effectiveness. Participants needed prior CAPTCHA experience to proceed. We recorded completion times and discarded results completed in under 15s, though none were disqualified. We received 154 MTurk responses, discarding four incomplete ones. All 109 responses from university users were valid.

2.3 Demographics

Table 1 summarizes respondents' demographics. Our survey included 259 valid respondents: 62% male and 32% female. Only 14% of university users were

female, aligning with the U.S. national average (18%). Respondents' ages ranged from 19 to 70, averaging 32 with a standard deviation of 11.39. The largest age group (25–34) comprised 41% of respondents (107 out of 259), with 69 MTurk users and 38 university users. 60% of university users (65 out of 109) were aged 18–24. Over 70% of MTurk users held a bachelor's degree or higher, while 88% of university users were pursuing their first bachelor's degree. 86% (223) were native English speakers. University users had relatively more non-native English speakers (20%), reflecting the university's diversity.

Table 1. Demographics

	MTurk		Univ.		Total	
	No.	%	No.	%	No.	%
Gender						
Male	82	55	90	83	172	66
Female	68	45	15	14	83	32
Non-binary	0	0	2	2	2	1
Decline to say	0	0	2	2	2	1
Age						
18-24	6	4	65	60	71	27
25-34	69	46	38	35	107	41
35-44	38	25	5	5	43	17
45-54	19	13	1	1	20	8
55-64	12	8	0	0	12	5
64 or older	6	4	0	0	6	2

	MTurk		Univ.		Total	
	No.	%	No.	%	No.	%
Education						
Less than high school degree	2	1	0	0	2	1
High school degree	9	6	5	5	14	5
Some college experience	17	11	55	50	72	28
Associate degree	15	10	36	33	51	20
Bachelor's degree	85	57	13	12	98	38
Postgraduate degree	22	15	0	0	22	8
Language						
Native English speaker	136	91	87	80	223	86
Non-native speaker	14	9	22	20	36	14

2.4 Hypotheses

This study tested the following null hypotheses: Between the two user groups,

- (H1) No significant difference in preferred CAPTCHA types.
- (H2) No significant difference in perception of solving CAPTCHAs on smaller devices.
- (H3) No significant difference in reasons for abandoning CAPTCHAs.
- (H4) No significant difference in perception of CAPTCHA difficulty.
- (H5) No significant difference in perception of CAPTCHA security.
- (H6) No significant difference in overall opinion of CAPTCHAs.

3 Findings

We analyzed the data from the Likert and closed-ended questions to determine differences between MTurk and university users' perspectives on CAPTCHAs.

Use and Preferences on CAPTCHA Types. We surveyed respondents on various CAPTCHA types: math, text identification, image recognition, image drag and drop, audio/video, and game/puzzle. Image recognition was the most prevalent (224 votes, 89%), followed by text identification (189 votes, 75%), with audio/video CAPTCHAs being the least used (57 votes, 23%). These results align with the widespread use of Google reCAPTCHA v2. Respondents ranked their preferences on a scale of 1 to 5. Figure 1 shows the preferences of MTurk users, and Fig. 2 presents those of university users. MTurk users preferred text identification (55 votes, 37%) and image recognition (45 votes, 31%), while university users favored image recognition (33 votes, 31%) and text identification (23 votes, 22%). Over half of university users never solved the other four CAPTCHA types, whereas MTurk users showed more diverse usage. An ANOVA test revealed significant differences in preferences between the groups ($p < 0.05$), possibly due to age, as most university users were under 25.

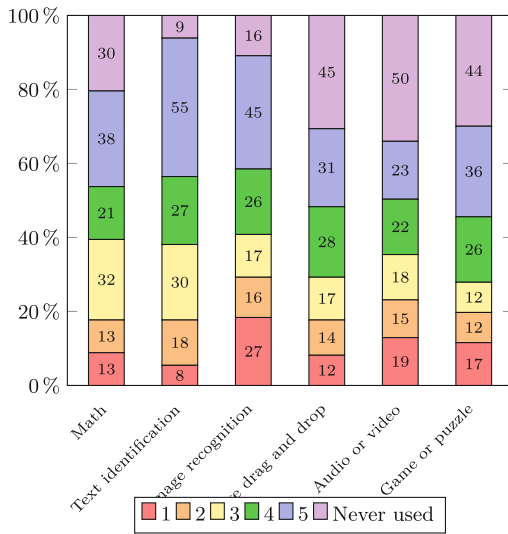


Fig. 1. Preferences of MTurk users

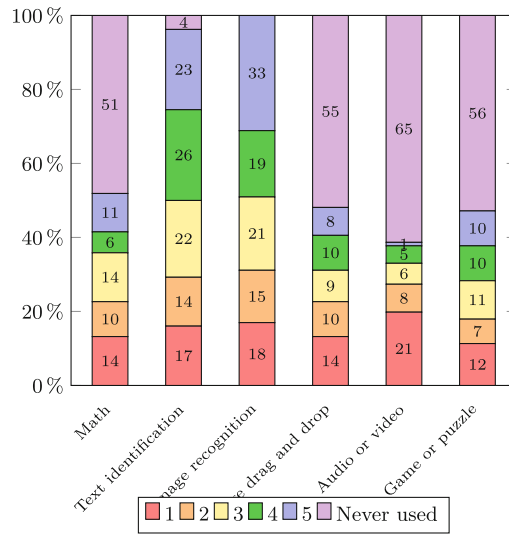


Fig. 2. Preferences of university users

CAPTCHAs in Non-English Languages. Only 3% of respondents encountered non-English CAPTCHAs, mostly in Portuguese (37.5%), followed by Hindi, Tamil, Turkish, French, Japanese, and Korean. Among these, 50% preferred text-based CAPTCHAs, 13% favored audio/video CAPTCHAs, and 25% liked both. However, more research is needed due to the small sample size.

Solving CAPTCHAs on a Smaller Device. 68% of respondents found solving CAPTCHAs easier on a computer than on a phone or tablet, while 32% saw no difference. A significant difference in opinions was noted between MTurk and university users (chi-squared $p = 0.0004$). Of the 172 respondents, 74% cited

size and orientation as the main reasons (73% MTurk, 78% university), and 58% considered input method (Touch vs. Keyboard/Mouse) essential.

Failing a CAPTCHA Challenge on a Single Attempt. Solving CAPTCHAs can be frustrating. In our survey, 28% of respondents always solved CAPTCHAs on the first attempt, as shown in Table 2. However, 3% of respondents consistently struggled. We also gathered their failure experiences through an open-ended question.

Table 2. Solving CAPTCHAs in one attempt

		MTurk	Univ.	Total
Always	n	52	19	71
	%	35%	18%	28%
Frequently	n	90	85	175
	%	61%	80%	69%
Rarely	n	5	2	7
	%	3%	2%	3%
		147	106	253

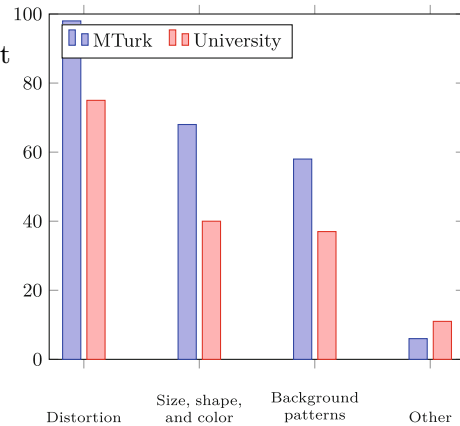


Fig. 3. Why CAPTCHAs are hard to use?

Respondents often cited image blurriness and unclear visuals as primary issues. For instance, P2 stated: “*I can’t always see the images clearly.*” P17 commented: “*Pictures too blurred or small to see properly.*” Text clarity was also a problem, with many finding the font, font size, and formatting difficult to read. P25 said: “*Cannot recognize font.*” P197 shared: “*CAPTCHA text or image can be distorted beyond recognition.*” Some respondents had to refresh the CAPTCHA for a clearer version. Another common issue was the perceived similarity of letters and numbers, such as ‘9’ vs. ‘g,’ “vv” vs. ‘w,’ ‘I’ vs. ‘1,’ leading to frequent mistakes. P73 explained: “*Some letter number combos like nine g and one I l and s f and o zero and similar letter number combo are very difficult to solve.*” These similarities often led to typing errors and failures on the first attempt. Human errors have caused many user failures, especially with image recognition and text identification CAPTCHAs. P259 shared: “*Mistaken letter or misheard a letter.*” P32 noted: “*Sometimes miss a picture or put a letter in the wrong place in a text CAPTCHA.*” Users often face difficulty deciding whether to select a particular image segment when only a small portion of the target object is visible. P163 highlighted: “*Normally incorrect image selected or character.*” Other common issues included carelessness, typos, accidental clicks, and rushing. Case-sensitive text CAPTCHAs posed challenges, often leading to multiple attempts. P64 shared: “*Typing a lowercase while CAPTCHA needs an*

uppercase.” This issue commonly leads to another problem: unclear instructions. P181 recounted: *“The image says to click all the stoplights, and I don’t know if it wants me to click the little bit on a square that is part of it but not really the stoplights.”* Our findings suggest obscuring instructions may be a deliberate tactic to increase CAPTCHA difficulty for bots.

Why Did You Give Up? We investigated if respondents ever left a webpage due to CAPTCHA failures. 75% of university users persisted until success, while nearly 65% of MTurk users abandoned the page, with 19% leaving immediately after one failure compared to 7% of university users. We also asked if users left a webpage simply to avoid solving a CAPTCHA. 62% of university users remained on the webpage despite a CAPTCHA, while 15% sought bypass methods. In contrast, 45% of MTurk users left due to challenging or annoying CAPTCHAs, and 20% found alternative bypass methods. The two groups showed significantly different behaviors ($p < 0.0001$, chi-squared test). Active MTurk users tend to complete tasks or jobs as much as possible within a given time frame, showing less patience for CAPTCHAs. University students, being tech-savvy and goal-oriented, show more patience during the authentication process.

Perceived CAPTCHA Difficulty. We asked respondents to identify the feature that contributes most to CAPTCHA difficulty. Figure 3 presents the distribution of votes from our participants. Distortion emerged as the top factor, aligning with the insights gathered from user responses in Sect. 3. Notably, 98 MTurk users (65%) and 75 university users (69%) endorsed this option. Size, shape, and color were also identified as troublesome factors, with 68 votes from MTurk users (45%) and 40 votes from university users (37%). Background patterns ranked third, albeit with a narrow margin (58 votes from MTurk users and 37 votes from university users). We then inquired about the trend in CAPTCHA difficulty over time. 43% of MTurk users felt that CAPTCHAs are getting harder, while 49% of university users believed that CAPTCHA difficulty has remained consistent. Conversely, 27% of MTurk users and 19% of university users found CAPTCHAs easier. A chi-squared test revealed significant differences between the two groups ($p = 0.008$).

Accessibility Concerns. Accessibility is crucial for user experience, yet several respondents shared frustrations. P12 noted that *“audio files sometimes did not properly load when solving an audio CAPTCHA.”* P181 encountered issues on mobile devices, particularly in touchscreen mode, stating: *“I was on a mobile phone and tried to solve a CAPTCHA and when I couldn’t click on the screen, I chose to make it an audio CAPTCHA and it failed to let me solve it.”* These complaints highlight common accessibility issues with CAPTCHAs on small screens.

How Secure Are Current CAPTCHAs? We assessed users’ perceptions of CAPTCHA security. The results indicate that 49% of MTurk users praised

CAPTCHA effectiveness, while 45% agreed that CAPTCHAs do a decent job. Conversely, only 15% of university users expressed high confidence, with 70% thinking CAPTCHAs are okay. Regarding CAPTCHAs keeping up with advancing attacks, 69% of university users were uncertain, with only 25% confident. Similarly, 41% of MTurk users shared this uncertainty, while 44% were confident. These findings suggest university users are more aware of security threats since many of them have taken security courses and are tech-savvy. However, they also highlight the need for greater public awareness and education on cybersecurity.

Final Stance. The final question aimed to gather respondents' overall opinions on CAPTCHA security and usability. Table 3 shows that among university users, 44% found CAPTCHAs secure and 66% found them usable. In contrast, 64% of MTurk users considered CAPTCHAs secure, with 55% finding them usable. Only 6% of MTurk users and 8% of university users viewed CAPTCHAs as neither secure nor usable. A significant disparity in opinions between the two groups was evident ($p = 0.021$, chi-squared test).

Table 3. Final stance on CAPTCHAs

	MTurk	University
Secure and usable	35 (24%)	20 (19%)
Secure but usability is a concern	57 (40%)	27 (25%)
Usable but security is a concern	43 (30%)	50 (47%)
Neither secure nor usable	9 (6%)	9 (8%)

4 Discussions

All six null hypotheses were rejected, indicating significant variations in user perceptions of CAPTCHA issues between MTurk and university users.

We observed distinct preferences for CAPTCHA types and differing perspectives on CAPTCHA difficulty. While more MTurk users claimed to solve CAPTCHAs on the first attempt (35% vs. 18%), they also gave up more easily compared to university users, who showed greater persistence. Age played a role in these differences, with MTurk users generally older (96% aged 25 or older) than university users (60% under 25). Our results aligned with previous research [5], indicating younger individuals prefer different CAPTCHA schemes on smartphones. Moreover, our study supported the finding that older participants are more likely to solve CAPTCHAs on the first attempt [2].

Despite higher education levels (72% with a bachelor's or postgraduate degree), MTurk users showed less concern for CAPTCHA security (64% considered it secure) compared to university users, who were more aware of online security threats.

Both groups found solving CAPTCHAs on smaller devices equally challenging (100% for MTurk users, 99% for university users), with screen size, orientation, and input methods as top obstacles. Many CAPTCHA issues persisted or worsened on smaller devices. We support recommendations by Reynaga et al. [5] for CAPTCHAs on smaller devices to adopt cross-platform input mechanisms, maintain consistent orientation, and employ minimalist designs.

CAPTCHAs remain difficult to use and heavily rely on visual processing, rendering them inaccessible to millions with visual impairments. There is a need for simpler, less burdensome solutions. Google's reCAPTCHA v2 introduced *Invisible CAPTCHAs* in 2014, but privacy concerns remain. We advocate for an invisible, passive CAPTCHA scheme leveraging user device data and behavioral activities, with transparency about data use. Our future agenda includes developing and testing this new mechanism to address these concerns.

5 Conclusion

This study surveyed 259 respondents from a university and Amazon Mechanical Turk to examine user perceptions of CAPTCHA usability and security. Our findings revealed significant disparities between the two groups. We explored possible explanations for these differences, including age and technical background. Both groups struggled with current CAPTCHA schemes, leading to failure and frustration. Our insights offer recommendations for more user-friendly CAPTCHAs and can guide future research in developing more effective solutions.

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