BOTS IMPACT ON ONLINE SURVEYS WITHIN SPECIAL EDUCATION RESEARCH

by

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Abstract

Researchers use online surveys to collect data from diverse populations (Phillips, 2017; Simone, 2019a). With the use of online surveys comes the potential for Artificial Intelligence Bots (AI Bots) to enter a survey and pose as valid participant. In this study we asked participants to inform us about their online research and if bots impacted their research in any way. To be eligible for the survey participants had to conduct an online survey in the field of special education research from 2010 to present. The participants could report up to ten surveys they have conducted since 2010 and if bots impacted their online survey. Out of the 88 surveys reported, 50 surveys (56.8%) had known or suspected bots. Of the participants who reported having known or suspected bots the mean percentage of bot responses in their data set was between 21%-40% of survey responses. When participants had known or suspected bots in their survey they reported having an increased amount of time during data cleaning. Having an increased number of bots in your survey can lead to data results being skewed (Storozuk et al., 2020). Currently, there is no research on how published online research results might be skewed due to bots posing as participants.

Bots Impact on Online Surveys within Special Education Research

Educational researchers rely on survey data. Surveys provide the opportunity for researchers to collect and use data from a variety of populations (Phillips, 2017; Simone, 2019a). Surveys can provide researchers with a wealth of knowledge, especially in the field of special education where the use of surveys in research is very high. More than half of the published research in special education from 1999-2019 was descriptive-correlational research which included surveys (King et al., 2023). This trend has continued as descriptive-correlational survey data is still commonly used in special education (e.g., Lombardi et al., 2022; Thompson et al., 2005).

Traditional versus Online Survey Design

Historically, surveys occurred in a variety of formats. Formats range from physical direct mail recruitment, calling participants and having them answer the questions on the phone, or meeting the participants in person. As technology has become more readily available so have online surveys and using the internet to recruit participants.

While using online surveys has its benefits, such as reaching a larger participant pool, lower costs, and using different recruitment strategies like snowball recruiting. It can also come with a lesser-known risk that can have a great impact on data reliability and usability. This risk is bots posing as participants in an online survey (Bowen et al., 2008; Simone, 2019a; Storozuk et al., 2020; Teitcher et al., 2015).

Bots are artificial intelligence created by humans to work with the underlying code of a survey (Pozzar et al., 2020). Bots can easily participate in a survey and their responses look like a typical respondent (Storozuk et al., 2020). These respondents can be hard to identify and are a problem within online research. This is due to the fact that their response to a survey can look

like a real participant which can skew data sets (Storozuk et al., 2020). The impact of bots in the already published research is unknown (Storozuk et al., 2020).

Bots within Online Research

Given the reliance of surveys in educational research it is important to note how many of the surveys include an online component. Simultaneous to the increase in online surveys, bots and malicious use of AI on the internet has substantially increased (Imperva, 2022). In 2021, bots accounted for 42.3% of all website traffic, with bad bots (those with malicious intent) making up 27.7% of all website traffic (Imperva, 2022). Particularly relevant to researchers and online surveys, bots are typically more drawn to surveys that have a financial incentive (e.g., raffle or gift card for participation; Teitcher et al., 2015).

Impact of Bots in Online Research

There are current best practices in survey design and implementation to help ensure nonbiased responses (Leko et al., 2022; Phillips, 2017; Rickards et al., 2013). These best practices allow the use of data in an unbiased manner. Researchers' poor survey design and data cleaning strategies are the current leading factors in skewed results (Kovacs et al., 2021). Currently, however, there is no published research on the new area of creating surveys specifically for an online environment. The use of online surveys versus other historical methods, like mailing surveys, allows researchers to reach a large diverse population quickly and is a cost-effective way of collecting data from a large number of participants (Phillips, 2017).

Technological advances have led to survey responses from bots looking more like real participants (Storozuk et al., 2020). These bots pose as real participants by answering questions within a survey. Bots can take the survey many times (Pozzar et al., 2020; Simone, 2019b). This leads to unreliable responses and duplicate responses (from humans and bots). Having unreliable

responses can result in skewed, bias, or invalid data. Throughout the years bots have become more sophisticated and are able to evade barriers in surveys designed to prevent bots (Pozzar et al. 2020; Simone, 2019a; Storozuk et al. 2020; Teitcher et al, 2015).

Bots are a current problem that needs a solution that will mitigate the impact bots can have on data. The progression and increased use of language learning models have caused a new wave of threat to research reliability (van Dis et al., 2023). Language learning models produce responses to questions asked (van Dis et al., 2023). With language learning models the participants are becoming harder to determine if they are eligible participants or a bot designed to take the survey.

Examples of Online Surveys Impacted by Bots

Bots can lead to surveys having high numbers of invalid responses. The following two research studies were by researchers who were aware that bots existed and could infiltrate a survey. Pozzar et. al (2020) recounts survey recruitment and design problems that led to having 271 survey responses within the first 7 hours of the survey being live. While having a quick response rate is what researchers typically want, Pozzar et. al (2020) found that the majority of respondents were invalid responses. After further analysis of the survey responses the research team flagged 256 respondents (94.5%) as fraudulent responses including known/suspected bots. In Simone's (2019b) study she had 400 responses in the first 12 hours. This resulted in the team flagging more than 97% of the responses (all but 11) as bots. This impact on her survey would have led to her dispersing more than $6,000 to fraudulent responses if not caught.

While some researchers anticipate the impact of bots, others are unaware of bots until a bot surge occurs in their study. This then leads to the researcher having to find ways and turn to current research to identify bots when cleaning the data. In Brodhead's (2023a) study they had

5,240 responses and after using a filtration system they deemed only 317 of the 5,240 as valid participants. When talking about the same study, Brodhead (2023b) reports that they would have given out more than $49,000 to fraudulent participants. Finally, in Schles and Deheck (preparation) another online survey that reached out to the Teachers of the Visually Impaired had 510 responses with 219 responses being removed. The research team flagged 84 of the 219 responses removed as definitive bots. Within these four online surveys, bots comprised a large number of responses that could have impacted the data greatly if not caught. Furthermore, large sums of money would have been spent by the research teams on invalid participants if detection measures had not been put into place.

Knowledge of Bots and Need for Training

Many researchers were unaware of bots until they entered surveys posed as participants (Bowen, et al., 2008; Teitcher et al., 2015; Ji et al., 2015; Griffin et al., 2022). Once bots have entered a survey, they can impact data and reliability (Bowen, et al., 2008; Teitcher et al., 2015; Ji et al., 2015; Griffin et al., 2022). Assessing the awareness level of researchers and the impact bots can have on the survey's reliability is a key first step in understanding the potential scope of this issue. Being aware of the signs of bots and how to identify and deter bots from a survey is imperative to make sure the data and research are reliable.

Bot Prevention Strategies

Automated strategies are bot prevention strategies that are already built into survey platforms. These automated strategies deter and detect bots without human intervention. One automated strategy is enabling a reCAPTCHA in the survey. The reCAPTCHA has participants prove they are human by answering questions (Pozzar et al. 2020; Simone, 2019a; Storozuk et al., 2020; Teitcher et al, 2015). There are also manual bot protection strategies. Manual strategies

are ones the research team puts in place to deter or identify bots, for example having hidden questions or honey pot questions (Griffin et al., 2021; Pozzar et al., 2020; Schles & Deheck, in preparation Storozuk, et al., 2020; Simone, 2019b). There is also a level of bot protection and defense that comes within recruiting for the survey. Publicly sharing a link online (via email, message boards, social media, etc.) helps the survey responses represent a true unbiased sampling of the population but can also attract bots to a survey (Teitcher et al., 2015). The current research suggests not posting the survey on social media (Perkel, 2020; Pozzar et al., 2020; Schles & Deheck, in preparation; Storozuk, et al., 2020). Instead have individualized links sent to participants (Perkel, 2020; Pozzar et al., 2020; Schles & Deheck, in preparation). Knowing the prevention strategies can be beneficial during the data cleaning process. While there has been research on the impact of inflicting biases and human error in the data cleaning process (Creswell & Creswell, 2018; Kovacs et al., 2021) there has not been research on how researchers are unknowingly keeping fraudulent responses and how it impacts their studies results. There has also not been research done on how bots have negatively impacted the data cleaning process for researchers.

Lack of Research on Bot Impact in Special Education Research

There is no research on special education researchers' knowledge or handling of bots, nor the impact bots have. Having the information on how widespread bots are, would be beneficial to see where the field for special education can grow within research methodology. It is important to inform researchers of the strategies to incorporate during the survey design phase that will help deter bots. Being able to deter bots or having an easier way of identifying bots will help with data cleaning processes (Storozuk et al., 2020; Teitcher et al., 2015). Making researchers aware of the current problem impacting online research and how to mitigate it is key to

continuing to have research that we can rely on. Having more research on bots will then provide us with a better understanding of how bots have made an impact on past and current research studies.

To address the gaps around special education researchers' knowledge and experience with bots, the following research questions are being asked: (1) Do researchers' online survey experiences and the impact of bots in a survey vary based on (1a) survey recruitment methods? Or (1b) survey platform? and (2) What are researchers' perceived impact of bots on their online survey who self-reported having known or suspected bot involvement in their survey?

Methods

Eligibility

The survey was open to individuals who conducted a United States-based IRB-approved online survey within the field of special education between January 2010 and the present (June 2023). The research team defined online research as using an online survey for either original research or recruitment. The field of special education refers to online research as: research intended for dissemination and/or improvement of services and supports for children, youth, young adults with disabilities, their families, teachers, and related service providers. The research project excluded medical and pharmaceutical studies.

Recruitment

The research team used multiple methods of recruiting. These methods included: emailing university faculty and research staff directly within the field of special education, particularly at R1 and R2 institutions, applied behavioral analysis and speech-language pathologists, social media posts by the PIs, and sharing research opportunities through the professional networks including Vanderbilt Kennedy Center, The University Centers for

Excellence in Developmental Disabilities (UCEDD) and Association for Education and Rehabilitation of the Blind and Visually Impaired (AER) Personal Prep listserv. The research team also used a snowball recruitment method asking individuals who read or received recruitment emails or social media posts to share the opportunity with others.

Survey Tools

The study consists of two survey tools. The first survey was a screener survey. The primary purpose of the screener was as a universal public link for prospective participants. The second purpose was to gather general information on prospective participants so that the research team could identify valid from invalid perspective participants. Once the research team identified a screener response representing a valid participant, the participant then received an individualized link to the second survey tool which was the main survey. The main survey had more specific questions regarding the participants' experience with conducting online research through surveys, awareness of bots, and whether bots impacted their research. Appendix A is the screener survey. Appendix B is the main survey.

Screener Survey Review Procedures

The participants first answered open-ended questions in a screener survey to determine participant eligibility. Two trained members of the research team independently reviewed screener responses to determine if the entry was a valid entry from an eligible participant. The two-person team consulted with one or both co-PIs to make a final decision when the determination was not clear. If the team (two researchers and two PIs) thought the participant needed a closer look, then the team provided an individualized link to the main survey. The team flagged the participant for a close review should they complete the main survey. The close review ensured the participant was eligible and their response should be included in the final

dataset. Allowing participants to complete the survey when the research team was unsure was to prevent bias and make sure the survey had a diverse nonbiased response pool. After the research team approved the responses the participants received an individualized link to the main survey. If the research team deemed a response ineligible, then the participant did not receive access to the main survey.

Main Survey

The main survey consisted of two sections. First, questions regarding the demographics of the participants that included their gender, age, prior research methodology training, and if the training mentions online bots. In the second section participants could share their experiences conducting up to 10 different online surveys they conducted from 2010 to the present (with the same questions repeating for each survey experience they wanted to share). Questions for each survey they conducted included the year and focus of the survey. Additional questions included reporting on recruitment methods and if they included any bot mitigation strategies in their survey. The survey then asked participants if they had knowledge of any bots entering their survey. If the participant was aware of bots entering their survey then they were asked about the impacts the bots had on recruitment strategies, data cleaning, and data analysis. Participants then estimated how many responses they thought were bots in their survey and what strategies they used to identify any bots.

Research Question 1: Variables of Interest

Presences of Bots in Online Surveys (Outcome Variable)

The primary variable of interest for Research Question 1 is if the researchers perceived that there were any bots present in their online survey. Participants were asked if they had any

known or suspected bots in their survey. The participants had three choices to choose from "Yes", "Maybe but we are unsure", and "No".

Covariates: Participant Demographics

Participant Gender. We asked participants what gender they identify as. There were five options to choose from. These options included female, male, non-binary, other, and prefer not to answer.

Participant Age. We asked participants their current age in years. The participants had 12 options to choose from starting at age 20 and increasing in 5-year increments (e.g., 20-25, 26-30, 31-35, etc.) with the last option being 76+.

Research Training. Participants were asked if they had received any training in research methodology before conducting their first survey. The participants were asked to select all that applied from five options. The response options were 1. Undergraduate work, 2. Master's level work, 3. Doctoral level work, 4. Professional development training outside of coursework, 5. No they did not receive any training.

Research Training in Bots. If participants reported that they had received research training, they were then asked if the research training discussed online bots within social science research. The question was phrased in a yes/no format.

Covariates: Survey Details

Survey Year. The research team asked the participants what year they completed the survey they were sharing information on. Responses options ranged from 2010 to 2023. If a survey span two calendar years participants were directed to report the year they began survey recruitment.

Survey Platform. Participants were asked what survey platform they used for their online survey. The participants chose from 5 options (Qualtrics, REDCap, Google Forms, SurveyMonkey, and other). If the participant chose other then they would have the option to write in the platform they used.

Recruitment Methods. Participants were asked what recruitment methods were used to get the word out about their survey. Participants could select all that applied from a list of 11 different options. These options included 1. Direct email to potential participants, 2. Listservs, 3. Organization newsletters, 4. Website, 5. Digital flyer, 6. Paper flyer, 7. Facebook, 8. Twitter, 9. Instagram, 10. Reddit, and 11. Other. If other was selected, then the participants had the option the write in any other recruitment method they used.

Data Analysis

Rather than analyzing across participants, we looked across all eligible surveys reported. This means that each survey reported makes a unique data point. Descriptive statistics were calculated for each variable. This consisted of mean, range, standard deviation, and frequency. After descriptive statistics were run, Chi Square tests was run on the following variables: gender, age, survey year, research training, research training in bots, recruitment methods, and the platform used to test for statistical significance against the outcome variable of suspected bot. To further analyze the data, correlations were run on the following variables: suspected bot, participant age, Qualtrics, SurveyMonkey, listservs, newsletters, websites, digital flyer, Facebook, and Twitter. For the Chi Square test and the correlations suspected bot responses options “Yes” and “Maybe” were combined to make a binary variable. Combining “Yes” and “Maybe” was done after running the statistics multiple ways and the response options for “Yes” and “Maybe” performed about the same leading to combining the options into one.

RQ 2: Bot impact on online Surveys

Participants who reported yes or maybe to having bots in their online survey were directed to answer additional questions specifically about the involvement or impact of bots. Below are the variables that we will examine to address research Question 2 (What are researchers' perceived impact of bots on their online survey who self-reported having known or suspected bot involvement in their survey?).

Estimate

Participants were asked to estimate the portion of survey responses they attributed to bots. Response options were in the form of the overall percentage of survey responses the participants thought could be attributed to bots, in 10% increments ranging from 0-10% through 91-100% of received responses in their survey.

Survey Recruitment Bot Impact Rating

Participants were asked to rate the impact bots had on development and recruitment for the survey on a scale of 0-7. Participants would move a slider bar to indicate impact 0 being no impact, 4 moderate impact, and 7 being major impact.

Description of How Bots Had an Impact on Recruitment

Participants were asked how they would describe the impact bots had on their survey development and recruitment. Participants were asked to select all that applied out of the three answer choices. The choices consisted of 1. Increase in time and human effort spent on survey recruitment, 2. Preparing for potential bot responses influenced how we conducted recruitment, and 3. Other. If participants selected other then they would have to opportunity to write in other impacts bots had on survey development and recruitment.

Post Survey Bot Impact Rating

Participants were asked to rate the impact bots had on data cleaning/preparation for analysis and other post-survey completion tasks. Participants would move a slider bar to indicate impact 0 being no impact, 4 moderate impact, and 7 being major impact.

Description of How Bots Impacted the Survey After the Survey was Completed

Participants were asked how they would describe the impact of bots on their survey after the survey was completed. Participants could select all that applied from five answer choices. These choices included 1. Increased the time and human effort spent on data cleaning, 2. Number of bot responses received rendered the survey invalid and unusable, 3. Identifying bots increased the cost/budget for the survey, 4. No impact, 5. Other. If participants selected other then they had the option to write in their response.

Data Analysis

For data analysis descriptive statistics were calculated for each variable. This consisted of mean, range, standard deviation, and frequency. Descriptive states are being reported as this dataset is a subset of participants. If participants answered that they had known or suspected bots in their survey then they had access to report on the questions above. Within data analysis we are looking across surveys the participants reported on rather than analyzing across participants. Meaning that each survey a participant reported on is a unique data point even if the information is reported by the same participant.

Results

The survey had a total of 79 approved screener responses and were sent individualized links to access the main survey. Of the 79 individualized links sent, 62 participants completed (in full or part) the main survey. There were 60 eligible participants with full or partially completed main survey responses. Two participants were ineligible because they did not meet the inclusion

criteria as their surveys were not related to special education. The research team then expanded the data set where each survey a participant reported became it's own case. Additional data cleaning found 5 ineligible surveys reported, which were removed from the dataset. Examples of what made a reported survey ineligible were the survey was out of the eligible date range, or the survey topic was not clearly related to special education. After the removal of ineligible surveys, the dataset was expanded and 60 participants reported on a total of 88 eligible surveys. Of the 60 participants, 4 participants only reported demographic information. When focusing on participant demographic information the results will be reported out of the 92 responses (88 reported surveys plus 4 participants with demographic information only). When looking at survey experience questions the data will be reported out of the 88 reported surveys from 56 participants.

Research Question 1: Variables of Interest

Presences of Bots in Online Surveys (Outcome Variable)

There were 88 responses to the question regarding whether the researchers thought there were any suspected bots in their survey. Of the 88 responses 28 (31.8%) responses reported yes there were bots in their survey. Twenty-two (25%) reported there maybe were bots in their survey. Thirty-eight (43.1%) reported there were no bots in their survey. Resulting in 50 of the 88 responses or 56.8% of responses having known or suspected bots in their survey.

Variables of Interest (Demographics)

Gender. Nighty-one participants reported their gender. In Table 1 are the frequency counts and the percentages for the participant's gender.

Table 1.

Frequency of Participants Gender

Gender	Frequency (*n*)	Percent of Responses
Female	75	82.4%
Male	14	15.4%
Non-binary	1	1.1%
Other (write in options)	0	0%
Prefer not to answer	1	1.1%

Participant Age. Nighty-two participants reported their age. The minimum as was 26-30 years old, and the maximum was 70-75 years old. The mean age ranged between 36-40 years old and 41-45 years old and the standard deviation being approximately 5 years. In Table 2 the frequency counts and percentages for participants' age are reported.

Table 2.

Frequency of Participants Current Age

Age	Frequency (*n*)	Percent of Responses
20-25	0	0%
26-30	11	12%
31-35	28	30.4%
36-40	17	18.5%
41-45	13	14.1%
46-50	9	9.8%
51-55	3	3.3%
56-60	6	6.5%
61-65	4	4.3%
66-70	0	0%
70-75	1	1.1%
76+	0	0%

Research Training. The majority of participants $n = 83$ (94.3%) reported some level of training in research methodology. Few participants $n = 5$ (5.4%) had no research training. The majority of reported research methodology training occurred during the participants' doctoral degree work $n = 83$ (90.2%). Participants were asked to select all that applied to capture each

time they received research methodology training. Table 3 has the frequency and percentages of when the participants received their research training.

Table 3.

Frequency of When Participants Received Research Training

Research Training	Frequency (*n*)	Percent of Responses*
trained during their undergraduate degree work	12	13%
were trained during their masters level degree work	33	35.9%
trained during their doctoral degree work	83	90.2%
trained during a professional development training that was outside of course work	18	19.6%
reported having no training in research methodology	5	5.4%

**Note:* The percentage total is greater than 100% as participant could select more than one option.

Research Training in Bots. Of the participants who received some form of research methodology training. Only one participant $n = 1$ (1.1%) reported having research methodology training in bots. All other participants, $n = 86$ (98.9%), indicated their research training did not include bots.

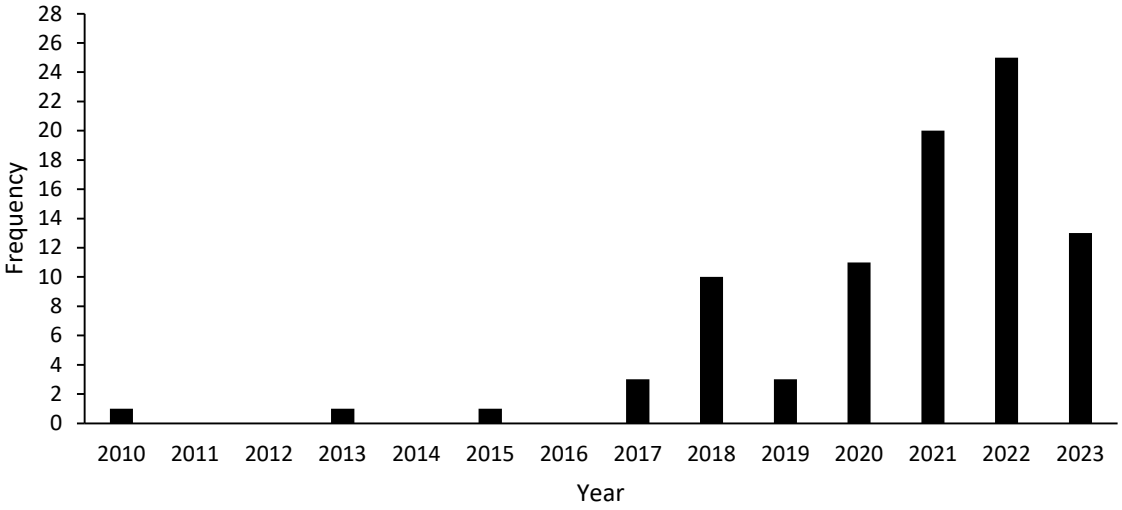
Covariates: Survey Details

Survey Year. When looking at when the surveys took place the mean was between 2020 and 2021 and the standard deviation was 2.26 years. The range of years was 2010 to 2023 with the median year being 2021. The frequency in the survey years reported is skewed left as the

majority of responses fell in the last five years. Figure 1 shows when the reported surveys took place.

Figure 1

Number of Surveys Reported for that Year



Survey Platform. The survey platform was reported for 88 surveys. For survey platforms, there were five response options for participants to select from. The majority of participants used Qualtrics n = 51 (58%) for their survey platform. Where n = 18 (20.5%) of participants used REDCap. Only n = 7 (8%) of participants used Google Forms. Then n = 6 (6.85%) participants reported using SurveyMonkey. Finally, n = 6 (6.85%) participants reported using an ’other’ platform. The ‘other’ platform responses consisted of Opinio, ASL SDI:SR, QuestionPro, Alchemer, MTurk, and Zoom.

Recruitment Methods. Recruitment methods varied across surveys. There are 11 response options (Direct Emails, Facebook, Listservs, Organizational Newsletters, Digital Flyer, Twitter, Websites, Paper Flyer, Instagram, Reddit, and other) participants could choose from. Table 4 has the frequency counts and percentages for the recruitment methods used. The ‘other’

responses consisted of but were not limited to using snowball recruitment, survey was part of a course, Qualtrics panel, word of mouth, conference announcements, summer camps, and discord.

Table 4.

Frequency of Recruitment Methods Reported

Recruitment Methods	Frequency (*n*)	Percent of Responses*
Direct Emails	63	71.6%
Facebook	45	51.1%
Listservs	40	45.5%
Organizational Newsletters	31	35.2%
Digital Flyer	30	34.1%
Twitter	22	25%
Websites	15	17%
Other	13	14.8%
Instagram	10	11.4%
Paper Flyer	5	5.7%
Reddit	2	2.3%

**Note:* The percentages will be more than 100% combined as the participants could select all that applied.

Chi Square Analysis

Chi Square Analysis was conducted to see if there was a relationship between the variables and suspected bot. The suspected bot variable was run as a binary meaning that the yes and maybe for bots in a survey were combined and the no remained the same.

Researcher Demographics

A statistically significant relationship was found between suspected bots and researcher age, χ^2 (8, N=88) = 18.25, p = .01. No statistically significant relationships were found between bots being in a survey and: gender χ^2 (3, N=87) = 2.10, p = .55; research training χ^2 (1, N=88) = 1.72, p = .18; research training in bots χ^2 (1, N=84) = .72, p = .39; nor survey year χ^2 (9, N=88) = 9.02, p = .43.

Platform

A statistically significant relationship was found between suspected bots and: Qualtrics χ^2 (1, N=88) = 4.79, p = .02; SurveyMonkey χ^2 (1, N=88) = 4.23, p = .04; and Platform Other χ^2 (1, N=88) = 4.23, p = .040. No statistically significant relationships were found between bots being in a survey and: RedCAP χ^2 (1, N=88) = .89, p = .34; nor Google Forms χ^2 (1, N=88) = 2.47, p = .11.

Recruitment

A statistically significant relationship was found between suspected bots and: listservs χ^2 (1, N=88) = 7.35, p = .007; newsletters χ^2 (1, N=88) = 3.90, p = .04; websites χ^2 (1, N=88) = 3.96, p = .04; digital flyer χ^2 (1, N=88) = 9.97, p = .002; Facebook $\chi 2$ (1, N=88) = 20.17, p = <.001; and Twitter χ^2 (1, N=88) = 5.0, p = .02. No statistically significant relationships were found between bots being in a survey and: emails χ^2 (1, N=88) = .73, p = .39; paper flyer χ^2 (1, N=88) = .02, p = .088; Instagram χ^2 (1, N=88) = 2.47, p = .11; Reddit χ^2 (1, N=88) = 1.55, p = .21; nor Platform other χ^2 (1, N=88) = .70, p = .4.

Correlation

The correlations were calculated by correlating the outcome variable which is suspected bot involvement with the variables of interest. The variable suspected bot was run as a binary with “yes” and “maybe” the responses combined. The variables of interest are participant age, survey year, Qualtrics, SurveyMonkey, listservs, newsletters, websites, digital flyer, Facebook, and Twitter. A positive correlation was found between suspected bots and: Qualtrics r (86) .233, p = .029; listservs r (86) .289, p = .006; newsletters r (86) .211, p = .049; digital flyer r (86) .337, p = .001; Facebook r (86) .479, p = < 0.001; Twitter r (86) .238, p = < .025. A negative correlation was found between suspected bots and: age r (86) -.375, p = < .001; SurveyMonkey r (86) -.219, p = .040. There was no statistically significant correlation was found between bots

being in a survey and the survey year r (86) .109, p = .310. Table 5 has a full list of the correlations between the variables of interest.

Table 5.

Correlations Matrix Between Having Bots in the Survey and Variables of Interest

Variables	1	2	3	4	5	6	7	8	9	10
1: Suspected Bot										
2: Age	-0.375***									
3: Year	0.109	-0.154								
4: Qualtrics	0.233*	-0.040	0.236*							
5: SurveyMonkey	-0.219*	0.298*	-0.195	-0.318**						
6: Listservs	0.289**	-0.094	-0.041	-0.101	0.025					
7: Newsletters	0.211*	0.049	0.049	-0.095	0.084	0.477***				
8: Digital Flyer	0.337**	-0.161	0.109	0.078	-0.099	0.407***	0.177			
9: Facebook	0.479***	-0.240*	0.130	-0.004	-0.096	0.532***	0.393***	0.562***		
10: Twitter	0.238*	-0.110	0.038	0.226*	-0.156	0.215*	0.128	0.308**	0.306**	

Note: ***Statistical Significance at the 0.001 level, **Statistical Significance at the 0.01 level *Statistical Significance at the 0.05 level

RQ2: Descriptive Statistics

The following analysis was completed looking only at the surveys which had known or suspected bot involvement. Fifty of the 88 participants had known or suspected bots in their survey. Meaning that 56.8% of total participants reported that they had known or suspected bots in their survey.

Estimate of Bots in a Survey

The participants estimated what proportion of the total survey responses could be attributed to bots. Results ranged from 0%- 100%. The mean is between 21-30% and 31-40% with the standard deviation being 30%. See Table 6 for a reporting of the frequency and percent of estimated survey responses from bots.

Table 6.

Frequency of the Estimation of Bot Responses

Percentage of Bot Responses	Frequency of the 48 participants (*n*)	Percent of the 48 participants
0-10%	26	54.2%
11-20%	2	4.2%
21-30%	2	4.2%
31-40%	1	1.1%
41-50%	5	10.4%
51-60%	0	0%
61-70%	1	2.1%
71-80%	1	2.1%
81-90&	5	10.4%
91-100%	5	10.4%

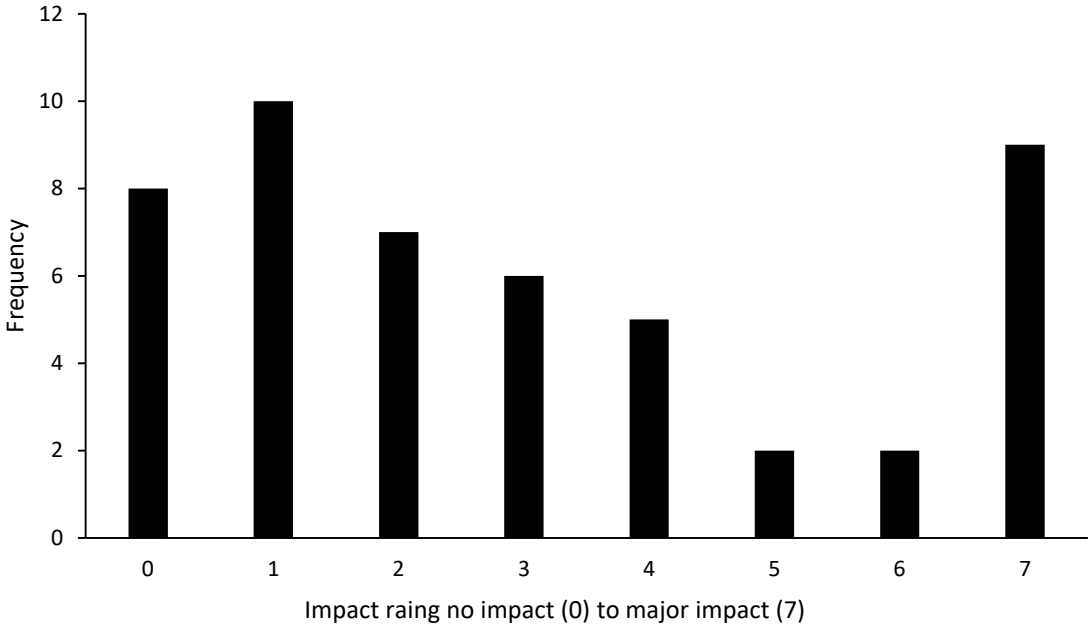
Survey Recruitment Bot Impact Rating

Participants rated the impact bots had during recruitment and development of the survey. On the rating scale 0 meant there was no bot impact, 4 was moderate impact and 7 was major impact. The mean= 3.0 which is closer to the moderate impact rating. The data has a bimodal

distribution with the majority of people either on the no impact or the major impact portion of the scale with the mean falling close to the middle. Figure 2 shows the distribution of responses.

Figure 2.

Survey Recruitment Distribution Bot Impact Rating Scale



How Bots had an Impact on Recruitment

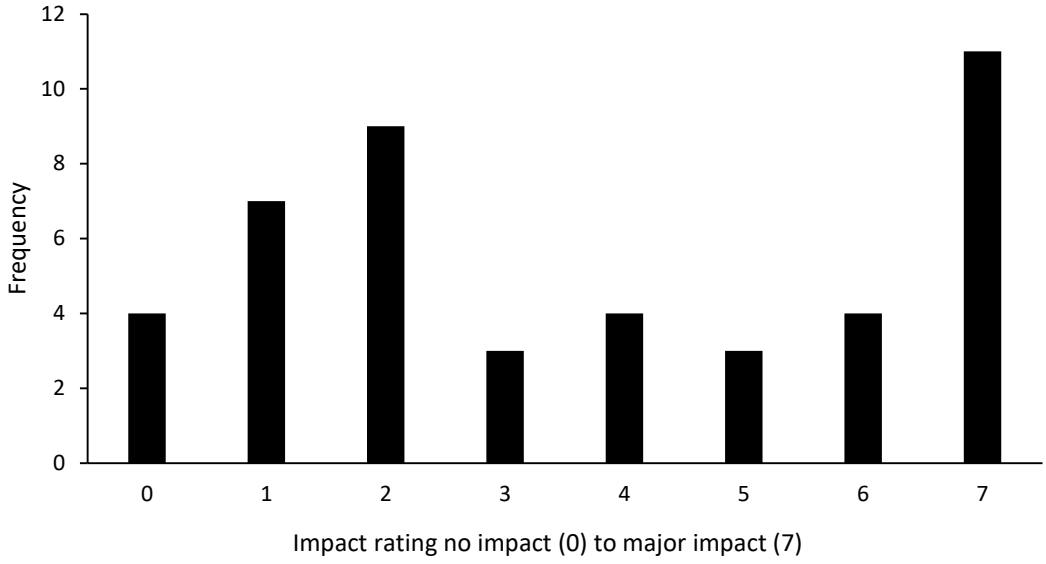
Participants who had known or suspected bots were asked to select all the options that best describe the impact bots had on survey development and recruitment by selecting all that applied from the four response options. Participants reported n = 22 (44%) had an increase in the time and human effort spent on survey recruitment. Preparing for potential bot responses influenced how we conducted the survey was reported by n = 15 (30%). No impact on recruitment was reported by n = 22 (44%). Finally, participants reported n = 8 (16%) bots having an 'other' impact. The 'other' responses consisted of but were not limited to: having to pause recruitment, having to contact IRB for help, having to change recruitment strategies, and having to create a plan to decipher who was a valid participant

Post Survey Bot Impact Rating

Participants rated the impact on post survey completion tasks. On the rating scale 0 meant there was no bot impact, 4 was moderate impact and 7 was major impact. The mean= 3.69 which is closer to the moderate impact rating. The data are bimodal with the majority of people either on the no impact or the major impact portion of the scale. Figure 3 shows the distribution of responses.

Figure 3.

Post Survey Distribution Bot Impact Rating Scale



Description of How Bots Impacted the Survey after the Survey was Completed

Participants who had known or suspected bots were asked to describe the impact bots had after the survey was completed by selecting all that applied from the six options. The majority of participants n = 25 (50%) reported an increase in the time and human effort spent on data cleaning (e.g., the time to sort through human and bot responses impacted the project timeline). Some participants n = 7 (14%) reported the number of bot responses received rendered the survey invalid and unusable. Participants also reported n = 12 (24%) identifying bots increased

the cost/budget for the survey (for labor or software/resources). Participants n = 14 (28%) reported having no impact. Finally, participants reported n = 4 (8%) bots having an 'other' impact. The 'other' responses consisted of but were not limited to: having to push the survey timeline back, having to start over, and bots began emailing the research team.

Discussion

While the benefits of online surveys consist of being cost-effective and reaching a diverse population, they do come with a risk of bots (Phillips, 2017; Simone, 2019a). The purpose of this study was to gather novel data of the effects and influences bots have had on special education online research surveys conducted between 2010 to 2023. In 50 of 88 reported surveys researchers had known or suspected in their online survey. Of the surveys having known or suspected bots the mean estimate of bots in the survey was between 21%-40% of survey responses were bots. Having a large portion of responses come from bots could be due to the form of recruitment methods the survey used. The recruitment methods of using listservs, newsletters, digital flyer, Facebook, and Twitter were highly positively correlated to having known or suspected bots in your survey. However, there is also the point that using the platforms of Qualtrics was positively correlated and SurveyMonkey was negatively correlated with having known or suspected bots in your survey. This could be due to Qualtrics becoming more popular over the last few years.

Did Training and Demographics have an Impact?

While it is common for researchers to receive research methodology training it is uncommon that these trainings address bots and how to prevent bots. Limited conclusions can be drawn from the current analysis as only one participant had training in bot prevention. Conversely, 83 of 88 participants did have research methodology training prior to conducting

their online survey. Research methodology training is important as it can aid in preventing researcher bias and participant bias in surveys (Leko et al., 2022; Phillips, 2017; Rickards et al., 2013). It is key to note that the relationship between researcher training and reported if bots were present in a survey was not statistically significant.

When looking at the age of the participant and having known or suspected bots were negatively correlated r (86) -.375, p = < .001. The variable participant age and the platform SurveyMonkey was positively correlated r (86) .298, p = < .005. However, SurveyMonkey negatively correlates with having known or suspected bots in your survey r (86) -.219, p = .040. These results could be due to a couple factors one being when the participant was trained in research methodology. A factor for SurveyMonkey being negatively correlated could be what year the platform was being used.

Were More Bots Present in More Recent Years?

Over the years bots have been becoming more prevalent online (Irish & Saba, 2023). With bots becoming more prevalent so have research articles addressing bots in online research. It is still not known the extent bots have unknowingly impacted research in the past. Surprisingly, having known or suspected bots in your survey was not correlated the year the survey was conducted. Meaning there is no statistical significance reported in regard to bots occurring more in current research, though the sample of this survey is small so limited conclusions may be drawn.

Do certain forms of recruitment increase the likelihood of having bots in your survey?

Current research states that online surveys are more susceptible to bots or lower-quality responses when the survey is posted online for recruitment (Douglas et al. 2023). We found this to be true. Within our research there was statistical significance between the 50 responses who

self-reported having known or suspected bots in their online survey and using the recruitment methods: digital flyer, Facebook, and Twitter. Meaning that having a social media presence increases the likelihood of having bots within your online research data. While research does have strategies to help prevent bots from entering your survey it is recommended to not post on social media (Perkel, 2020; Pozzar et al., 2020; Schles & Deheck, in preparation; Storozuk, et al., 2020). Research has even suggested that social media is not an effective form of recruitment as more ineligible participants respond from social media postings than eligible participants (Pozzar et al., 2020). If using social media then it should be done so with precaution and a close eye during data analysis to make sure all ineligible participants have been removed (Chen et al., 2023).

Survey Platform Impact

While previous research has not been conducted on specific platform usage and bot prevention we did find that Qualtrics had a positive correlation r (86) .233, p = .029; and SurveyMonkey had a negative correlation r (86) -.219, p = .040 when compared to having known or suspected bots in your survey. However, platforms have changed over time, and some have become more popular while the use of some has faded. With the change in platforms over time so has the number of bots online. In recent years the number of online bots has dramatically increased (Imperva, 2022). Looking deeper into the relationships between the variables, the survey platform and year have two possible key correlations. Specifically, Qualtrics and the survey year have a statistically significant positive correlation r (86) .236, p = .027. While surface-level interpretation of the data could be that one platform is more prone to bots, a more nuanced interpretation between the variables of suspect bot involvement, survey platform, and survey year is that Qualtrics has become a more popular survey tool in recent years. With

Qualtrics usage increasing over time and bots increasing it would lead to believe that both are growing in numbers leading to Qualtrics being more prone to bots as it is more readily used.

Bot Impact on Survey Design and Completion

We asked participants to report via a Likert scale the impact bots had during recruitment and data collection and cleaning. The results from both scales showed that participants either had hardly any impact or were very heavily impacted. Researchers are unaware until they have had a bot surge (Goodrich et.al 2023). The bimodal graph of each scale shows there is a real problem and researchers need to be made aware and trained in what to look for when bots have entered into the online survey. There is current research on different survey design strategies to implement to help prevent bots or make bots easier to identify. These strategies could consist of having a reCAPTCHA, duplicating questions, having logic checks, having questions with specific instructions, and having timestamps (Pozzar et al. 2020; Simone, 2019a; Storozuk et al., 2020; Teitcher et al, 2015). The current research also suggests having a plan to identify and remove bots (Storozuk et al., 2020; Teitcher et al., 2015). Some known bot markers are speeding through a survey, answering in a foreign language, having duplicate responses, and having responses that use the same sentence starters (Pozzar et al. 2020; Simone, 2019a; Storozuk et al., 2020; Teitcher et al, 2015). Bots are known to have a heavy impact on surveys and the results of the Liker scale show the divide in the research community regarding awareness of bot impact on surveys.

How were Surveys Impacted the Most

We asked how bots specifically impacted the survey during recruitment and data cleaning. During recruitment there was a tie as to the biggest impact bots had n = 22 (23.9%). The tie was between increased human effort in survey recruitment and no impact. This could be

because many researchers don't find out about bots until they get to the data cleaning phase (Goodrich et al. 2023). If researchers are not aware of bots until data cleaning then they cannot take appropriate steps during the survey design and recruitment phase to help prevent bots or slow bot responses when they have entered the survey. When participants were asked about the impact bots had on data cleaning the predominate response was increasing overall time during data cleaning n = 25 (38.5%). This can be due to having to research and learn what bots are and the ways to identify and remove bots. Another reason for prolonged data cleaning is that researchers have to develop a systematic plan to remove bots to help prevent the researcher from biasing the dataset (Storozuk et al., 2020; Teitcher et al., 2015). Once bots have entered your survey it can be time-consuming to weed out the bots especially if you are not aware of the current research strategies.

Limitations

There are several limitations that should be considered along with the findings of the study. It is important to reiterate the small sample size of respondents representing the online research community within the field of special education. Generalizing the results to the whole special education research community should be done with caution. Another limitation was not asking for further clarity of the survey's focus on the main survey. The questions regarding survey focus came in the screener survey but we did not ask any clarifying questions in the main survey. This might have led to some participants to be included in the main survey data when the survey they were reporting on did not explicitly meet the inclusion criteria. Finally, a limitation of this survey was including the digital flyer as a form of recruitment without defining digital flyer. Digital flyers could be interpreted by participants in many ways. This could lead to a misrepresentation of the respondents' survey recruitment. For example, some participants

selected recruiting on social media but not using a digital flyer and vice versa. Leaving the term digital flyer without a definition could have potentially skewed our recruitment method results. Having a definition of digital flyer would lead to having a more precise view of all the recruitment methods participants used.

Implications for Future Research

While previous research regarding bot impact on online surveys has come from researchers' experiences after bots have infiltrated their survey it is important to be proactive. This study showed that online research is being impacted by bots and researchers are either aware of the presence of bots or have had little exposure. The more awareness and research done on the impact bots have on online surveys the more proactive researchers can be in preventing bots.

Data cleaning is an important part of research as it helps make the data reliable and usable (Kovacs et al., 2021). However, the research team can unintentionally inflict bias on data when cleaning which is why it is important to have more than one researcher working on data cleaning (Kovacs et al., 2021). The current research reporting practices surrounding data cleaning is leaving out a key aspect which is how to remove bots. Knowing there is no research done on how bots can skew data results, research needs to be conducted. This research should also include already published research that might be unknowingly skewed due to bots.

While there are areas of growth needed in research around bots, there has been research done and guidelines created for researchers to reference for removal and prevention of bots (Storozuk et al., 2020; Teitcher et al., 2015). However, for researchers to implement the strategies surrounding bots they first need to be aware that bots can and will infiltrate surveys.

The more awareness and research done on the impact bots have on online surveys the more proactive researchers can be in preventing bots. The prevention of bots helps with data reliability and the amount of work needed during the data cleaning process. More research needs to be done on researchers' awareness of this problem and explicitly what steps they are taking to prevent bots. Bots are ever-changing and becoming smarter and it is important for researchers to keep up (Irish & Saba, 2023).

With bots continuing to evolve and becoming harder to identify this study would need to be expanded for future replications. For future replications, researchers would want to consider asking about/listing specific strategies used to prevent and identify bots. Also, asking participants if they believe these strategies are still effective. Finally making sure to have a clear picture of what the online survey was specifically used for and explicit examples of what recruitment methods the participants used. These changes will allow for more information to be collected and disseminated. Dissemination of this information is key to helping current researchers' try to stay one step in front of the bots or at least know what the new kings of bots infiltrating a survey are. Bots are a threat to research and data reliability that is only going to become harder to identify and mitigate as technology continues to advance.

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Appendix A

Screener: Special Education Research & Bots Survey

We want to know about your experience conducting online surveys in the field of early intervention, school-aged special education, and pre-and post-secondary transition supports and services in the United States. Because many researchers conduct multiple surveys over their careers, you will have the opportunity to tell us about multiple surveys. Within this survey, the term 'online research' refers to a formal online survey for the purposes of original research or recruitment of participants. The survey must have been reviewed and/or approved by an IRB approval process in the United States (inclusive of IRB exempt studies and studies identified by an IRB board as not needing approval.) The research in the survey(s) must have been intended for dissemination and/or improvement of services and supports for children, youth, young adults with disabilities, their families, teachers, and related service providers. Research topics may include early intervention, school-aged special education, pre-and post-secondary transition supports, and services. Excluded research topics do not include medical and pharmaceutical studies. **This is a screener to indicate interest in participating in the survey. Once we review your responses, an individualized link to the main survey will be sent to you.** The survey is being conducted by Dr. Olivia Enders & Dr. Rachel Schles. Dr. Olivia Enders can be reached at oenders@coastal.edu and Dr. Rachel Schles can be reached at Rachel.Schles@vanderbilt.edu This study is being conducted with the oversight of the Coastal Carolina Office of Sponsored Programs and Research Services and the Vanderbilt Human Research Protections Program. Coastal Carolina Office of Sponsored Programs and Research Services can be contacted at (843) 349-2978 Vanderbilt Human Research Protections Program can be contacted at (615) 322-2918 Note: The information you provide will be kept confidential. Only aggregated information will be publicly shared when the results of this survey are released.

- By checking 'yes' I acknowledge that I conducted an online survey (as defined above) in the United States at any point between January 1, 2010, to the present. I also agree to participate in both the screener survey and the full survey. An individualized link to the full survey will be emailed to you after your responses to the screener survey are reviewed.
    a. Yes
    b. No

- Name (First Name & Last Name)

- Email

- Confirm Email

- What was your role or job title when you were conducting the online survey?
  Note: If you've conducted multiple online surveys between 2010-present, please include each role/job title you held while conducting each survey?

- In what year(s) did you conduct the online survey research?
  Note: If you conducted multiple surveys, please list the year(s) for each survey, and/or if a single survey spanned multiple years.

- Briefly describe the focus of your online surveys. For example: surveying current special education teachers; understanding family experiences connecting with school services; or as an initial recruitment of prospective participants of a qualitative study.

- Please type 'yes' if you consent to us reaching out via email with an individualized link to complete the Special Education Bot survey.
  Please type 'no' if you do not consent to us reaching out via email with an individualized link to complete the Special Education Bot survey

Appendix B

Special Education Research & Bots Survey

Please complete the survey below.

Thank you!

We want to know about your experience conducting online surveys in the field of early intervention, school-aged special education, and pre-and post-secondary transition supports and services. Because many researchers conduct multiple surveys over their careers, you will have the opportunity to tell us about multiple surveys (up to 10). Within this survey, the term 'online research' refers to a formal online survey for the purposes of original research or recruitment of participants. The survey must have been reviewed and/or approved by an IRB in the United States (inclusive of IRB exempt studies and studies identified by an IRB board as not needing approval.) Within this survey, the term 'online research' refers to a formal online survey for the purposes of original research or recruitment of participants. Research intended for dissemination and/or improvement of services and supports for children, youth, young adults with disabilities, their families, teachers, and related service providers. Research topics may include early intervention, school-aged special education, pre-and post-secondary transition supports, and services. Excluded research topics include medical and pharmaceutical studies. You can stop participating in the survey at any time. At any point you can click the "save and exit" button to exit the survey and return to finish at a later point in time. Make sure to complete your responses before the survey closes. The survey is being conducted by Dr. Olivia Enders & Dr. Rachel Schles. Dr. Olivia Enders can be reached at oenders@coastal.edu and Dr. Rachel Schles can be reached at Rachel.Schles@vanderbilt.edu This study is being conducted with the oversight of the Coastal Carolina Office of Sponsored Programs and Research Services and the Vanderbilt Human Research Protections Program. Coastal Carolina Office of Sponsored Programs and Research Services can be contacted at (843) 349-2978 Vanderbilt Human Research Protections Program can be contacted at (615) 322-2918 Note: The information you provide will be kept confidential. Only aggregated information will be publicly shared when the results of this survey are released.

Demographic Questions

- What is your gender?
  a. Female
  b. Male
  c. Non-binary
  d. Other (write in option)
  e. Prefer not to answer

- Please specify your gender.

- What is your current age in years?
  a. 20-25
  b. 26-30
  c. 31-35
  d. 36-40
  e. 41-45
  f. 46-50
  g. 51-55
  h. 56-60
  i. 61-65
  j. 66-70
  k. 70-75
  l. 76+

- Did you receive any training in research methodology prior to conducting your first online survey?

(please select all that apply)

  a. In my undergraduate degree work
  b. In my master's level degree work
  c. In my doctoral level degree work
  d. Professional development training, outside of coursework
  e. No, I did not have any research methodology training prior to conducting my first online survey

- Did the research training you indicated above discuss online bots in social science research?

Note: "Bots" are not real participants, they are instead artificial intelligence codes that pose as participants through responding to online survey questions (Storozuk et al., 2020).

  a. Yes
  b. No

Because many researchers conduct multiple surveys over their careers, you will have the opportunity to tell us about as many as 10 different online surveys. You may tell us about as many or as few of your survey experiences as you would like. If you've completed more surveys than you'd like to tell us about, please prioritize the most recent surveys and any surveys which may have involved bots.

- In approximately what year did you conduct Survey #1?

If the survey spanned calendar years, select the year you started recruitment for Survey #1.

  a. 2010
  b. 2011
  c. 2012
  d. 2013
  e. 2014

f. 2015
g. 2016
h. 2017
i. 2018
j. 2019
k. 2020
l. 2021
m. 2022
n. 2023

- Please select which best describes your job title when you conducted Survey #1:
  a. Student (undergraduate, masters, or doctoral level)
  b. University faculty member
  c. Researcher (university-based, such as staff member or post-doc; not a faculty member)
  d. Researcher (non-profit or private company)
  e. Other (write-in)

- Job title for Survey #1 write-in option:

- Briefly describe the focus of online Survey #1
  (For example: surveying current special education teachers; understanding family experiences connecting with school services; or as an initial recruitment of prospective participants of a qualitative study)

- What platform did you use for online Survey #1?
  a. Qualtrics
  b. REDCap
  c. Google Forms
  d. SurveyMonkey
  e. Other (write-in)

- Platform you used for online Survey #1 write-in option:

- What recruitment methods did you use to get out the word about Survey #1?
  (Please select all that apply)
  a. Direct email to potential participants
  b. Listservs
  c. Organization Newsletters
  d. Website
  e. Flyer (digital)
  f. Flyer (paper)
  g. Social Media: Facebook
  h. Social Media: Twitter

i. Social Media: Instagram
j. Social Media: Reddit
k. Other (write-in)

- Please tell us what other recruitment strategies you used for Survey #1:

- Did you include any automated authentication procedures that participants needed to complete prior to starting Survey #1?
  (For example: CAPTCHA "Completely Automated Public Turing test to tell Computers and Humans Apart or reCAPTCHA)
  a. Yes
  b. No

- Why did you include an automated authentication on Survey #1?

- Why did you not include an automated authentication procedure on Survey #1?

- Did you include any manual authentication procedures that participants needed to complete prior to starting Survey #1?
  (For example a pre-survey screener)
  a. Yes
  b. No

- Why did you include a manual authentication procedure on Survey #1?

- Why did you not include a manual authentication procedure on Survey #1?

- Optional: Would you like to elaborate on your answers regarding survey authentication procedures in any more detail for Survey #1?

Bots are not real participants, they are instead artificial intelligence codes that pose as participants through responding to online survey questions (Storozuk et al., 2020).

- Did you have any known or suspected bot responses Survey #1?
  a. Yes
  b. Maybe but we are not sure
  c. No

- How would you rate the overall impact of bots in the development and recruitment for Survey #1?

- What bot identification strategies or procedures did you use in Survey #1?
  (please select all that apply)
    a. Specialized software designed to identify bot responses
    b. Identifying multiple responses with identical or near identical start and/or stop times
    c. Removing responses in foreign languages or illogical responses to open-ended questions
    d. None
    e. Other (write-in)

- Please explain other strategies you used to remove bots in Survey #1:

- How would you describe the impact of bots on Survey #1 in survey development and recruitment?
  (please select all that apply)
    a. Increased the time and human effort spent on survey recruitment (e.g., we closed down the survey and create new links after multiple bot responses were received)
    b. Preparing for potential bot responses influenced how we conducted survey recruitment
    c. None
    d. Other (write-in)
    e.
- Please describe other impacts bots had on Survey #1 regarding development and recruitment:

- Please rate the impact of bots on Survey #1's data cleaning, preparation for analysis, or other post-survey completion tasks.

- In your estimation, what proportion of your responses could be attributed to bots in Survey #1?
    a. 0-10%
    b. 11-20%
    c. 21-30%
    d. 31-40%
    e. 41-50%
    f. 51-60%
    g. 61-70%
    h. 71-80%
    i. 81-90%
    j. 91-100%

- How would you describe the impact of bots on Survey #1 after the survey was completed? (For example impact on data prep and analysis?)
  (please select all that apply)

    a. Increased the time and human effort spent on data cleaning (e.g., the time to sort through human and bot responses impacted the project timeline).
    b. The number of bot responses received rendered the survey invalid and unusable
    c. Identifying bots increased the cost/budget for the survey (for labor or software/resources)
    d. None
    e. Other (write-in)

- Please describe other impacts bots had on Survey #1 after the survey was completed:

- Would you like to share anything else about the impact of bots in Survey #1?

- How did you know there were no bot responses in Survey #1?

- Would you like to tell us about an online Survey #2 you conducted?
    a. Yes
    b. No

- Would you like to share anything else related to bots and your survey?

- Please select 'yes' to confirm you would like to end the survey and not provide additional information on any more surveys. If you would like to continue to provide additional information on more surveys please select 'no'.
    a. Yes
    b. No