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EXPLORING THE POTENTIAL OF ONLINE SCIENTIFIC RESEARCH TO MEET MODERN NEEDS: INTERNATIONAL PERSPECTIVE

Abstract. *The internet and digital technologies have brought about a significant change in the way scientific research is conducted, marking a paradigm shift in the field. This article explores how the internet has influenced and facilitated scientific research, along with the internal challenges and limitations researchers face in the digital age. Several examples of research and the attitudes of different categories of respondents towards the use of online tools are provided. With the help of online collaboration tools, researchers can work together from different parts of the world, share data in real time, and leverage interdisciplinary synergies to drive scientific progress. Access to vast online databases, journals, and repositories has also enabled researchers to speed up literature reviews and remain up-to-date with the latest scientific explorations. Moreover, the internet has facilitated the sharing of research data, code, and materials, promoting transparency, replication, and reuse of valuable scientific resources. However, online research is not immune to challenges, such as concerns about data quality, reliability, and validity. Online information may contain errors or intentional misinformation. Additionally, the digital divide and uneven global access to internet infrastructure can lead to sampling bias in online research. The article presents the advantages and disadvantages of using online tools for conducting research. It also highlights that the constant emergence of new online tools and platforms requires ongoing adaptation, and factors such as unique web browsing experiences and technological variations can impede the reproducibility of certain online studies. Despite these challenges, the article argues that the internet has become an indispensable tool for scientific research, creating both opportunities and challenges that the scientific community must skillfully navigate. The article aims to provide best practices for improving skills in areas such as data management, digital literacy, and virtual collaboration, which are crucial for the responsible and ethical advancement of scientific research in the digital age.*

Keywords: *online research; information society, research; Internet; accuracy, reliability, research technologies and methods.*

Problem statement. At the turn of the 20th and 21st centuries, there was an intensive increase in information, leading to dynamic changes in all spheres. These changes are global, which in turn leads to the creation of new social structures and prompts radical changes in the processes of communication, learning, and solving everyday and professional problems, which generally reflect the realities of social life. Rapid access

to computer devices and the Internet has also influenced the organisation and conduct of scientific research and increased the opportunities for research in various fields of knowledge. In addition, the Internet facilitates the establishment and maintenance of scientific contacts between researchers living in different countries and even on different continents. A good example is the online resources of scientific libraries or the “alphanumeric code created for the unambiguous identification of authors and co-authors of scientific and academic

publications”, called the Open Researcher and Contributor ID (ORCID).

Starting in 2009, there have been significant changes in the approaches to using data collection methods [1], the essence of which is that Internet research, which was virtually non-existent 20 years ago, has become dominant in the research field. Every day, a modern researcher is faced with the need to use the Internet, increasingly using networks to conduct their empirical research. This situation can be seen as an opportunity to enrich existing methodological procedures, but not as an alternative [2, p. 213]. Modern methodological research substantiates that the Internet is an indispensable research tool [3].

Analysis of recent research. Issues related to the organisation and conduct of online research have been the focus of domestic and foreign scientists for over twenty years. A retrospective review of scientific sources shows that already since the 90s of the 20th century, a sufficiently large number of works on this problem have been published. In particular, the researchers considered such issues as Internet surveys. Using the Internet as a data collection method [3]; using the Internet for surveys [4]; sampling for Internet surveys [5]; online surveys, review of problems and approaches [6]; online surveys in the field of pedagogy [7]; marketing research trends: online panels and online communities [8] etc. A separate direction is the research of social psychologists who study the Internet and its social context [3; 7]. The majority of foreign scientists believe that online research is the main trend of not only quantitative but also qualitative research. Summarising the scientific review of research efforts, scientists concluded that the Internet is used in almost every methodological paradigm: in experimental, quantitative and qualitative research, research using psychological tests, and the literature contains many interesting reviews and collective works that are worth using.

Therefore, as the use of the Internet becomes more accessible and its importance grows, this environment is becoming an increasingly important tool in conducting social and psychological research. Internet research can be conducted using various methods — from interviews and focus groups, through surveys and experiments, to the use of vast data resources — texts and records of user activity [9].

The study and analysis of many sources show that there are different points of view regarding the advantages and disadvantages of using the Internet for different types of surveys, including those of a scientific nature. In this context, the results of the analysis by American scientists D. Fricker and M. Schonlau, published in 2002, deserve special attention. In particular, they were among the first to study issues related to the quality, reliability, and accuracy of the results of Internet surveys. The authors analyzed the popular claims that Internet surveys can be conducted faster, more efficiently, cheaper, and/or easier than surveys conducted using conventional methods. The researchers emphasize that the criteria of cost and speed often do not justify the hype surrounding these methods. At the same time, they argue that Internet surveys can be conducted in effective and cost-effective ways and conclude that the importance of the Internet for conducting various types of research will grow over time [10, p. 347].

Thus, B. Gregor and M. Stawiszyński name the following main advantages of Internet research [11]:

- Lower cost compared to traditional research;
- Rapid research and results collection time;
- Interactivity and the ability to preview results;
- The ability to use multimedia;
- High flexibility, for example, the ability to clarify questions during the research.

Economists emphasise that the main factor in the spread of online research and the growing share of online panel surveys is the cost-saving factor. Moreover, all aspects of this factor are important: saving time, saving financial and human resources. Online research significantly reduces, first of all, the time interval, which is extremely important in today’s accelerated pace of life, when it is necessary to respond as quickly as possible to consumer needs or obtain operational information for making management decisions [12]. None of the traditional survey methods can provide such speed of information collection as online surveys.

Presentation of main results. According to Ukrainian researchers, no less important advantage of online surveys is the factor of accessibility to the respondent. New forms of communication with the respondent, with an interesting visual design of the questionnaire (video, images, animation) stimulate the respondent’s interest in participating in the survey and give them a sense of psychological

freedom [13]. We consider it appropriate to add 4 more important advantages:

- Technological efficiency (respondents' answers can be transferred to special software and/or spreadsheets for further detailed analysis, collected data can be visualised in the form of graphs, and tables);
- Convenience (participants can choose the most convenient time and form for themselves);
- Accessibility to the target audience (placement on websites of scientific institutions, higher education institutions, community forums or sending by e-mail in the text of a letter, as an attachment to a list of potential respondents);
- Environmental safety (the online survey format does not require the use of paper).

However, in addition to a whole set of advantages, research conducted in an online format also has certain disadvantages, although there are far fewer of them than advantages. This type of empirical research, despite its attractiveness, creates certain problems and carries the risk of methodological errors. First of all, it concerns the selection and representativeness of the studied sample.

The reliability of the obtained data should also be taken into account. No one can verify how truthful the respondents' answers are. However, traditional surveys cannot guarantee this either. Other disadvantages include: Internet users often ignore e-questionnaires or do not answer all questions; lack of external control, which can make the results less accurate and reliable; the identity of respondents is usually impossible to identify; the possibility of data falsification by participants or entering false information; difficulties in involving the elderly and people without adequate IT competence.

Here are some additional examples of how the Internet has influenced and facilitated scientific research:

Access to online databases and journals: Researchers now have easy access to a vast amount of scientific literature through online databases like PubMed, Google Scholar, Web of Science, etc. This has greatly sped up literature reviews and allowed researchers to stay up-to-date on the latest findings.

Online collaboration tools: Tools like video conferencing, shared documents/whiteboards, and project management software enable researchers in different locations to effectively collaborate on projects in real time.

Crowdsourcing data: Some studies leverage the internet to crowdsource data from large numbers of people through online surveys, games, etc. This allows for gathering bigger datasets than would be possible locally.

Computational power: Cloud computing services provide researchers with on-demand access to powerful computing resources to run complex simulations, analyse big data, etc.

Sharing research data/code: Online repositories allow researchers to publicly share datasets, code, and materials from their studies for transparency, replication, and reuse.

Science communication: The internet provides channels for researchers to communicate findings to the public and engage in science outreach through blogs, videos, social media, etc.

Citizen science projects: The internet enables the launching of citizen science initiatives where members of the public can voluntarily contribute data, computing power or analysis efforts.

Remote instrumentation: Some scientific instruments can now be operated remotely over the internet, enabling shared usage across locations.

So in many ways, the internet has democratized access to scientific knowledge, enabled global collaboration, provided new data sources/tools, and opened up science to broader participation.

While the Internet has provided many benefits for scientific research, there are also several challenges and limitations that researchers face when utilizing online tools and resources:

Data quality and reliability: Information found online may lack robust verification, containing errors, biases or even intentional misinformation. Evaluating the credibility of online data sources is critical.

Privacy and security concerns: Sharing sensitive research data or personal participant information online raises privacy and security risks that need safeguarding measures.

Limited access: Some key scientific publications and databases remain behind paywalls or have restricted access, limiting the free flow of information.

The digital divide: Uneven global access to internet infrastructure and technologies can lead to sampling biases when conducting online studies.

Distraction and information overload: The constant stream of online stimuli, notifications and inputs can make focused research efforts challenging.

Ethical issues: Online research involving human subjects raises concerns around informed consent,

anonymity, data protection and compliance with changing regulations.

Rapidly evolving technologies: The constant emergence of new online tools, platforms and practices requires ongoing adaptation by researchers.

Reproducibility challenges: Unique browsing experiences due to factors like location, device type, etc. can make replicating certain online studies difficult.

Lack of universal access: Not all scientific instrumentation and data sources are internet-enabled for remote usage yet.

Risk of virtual collaborator conflicts: Global cross-disciplinary teams may face communication, cultural or intellectual property challenges.

Despite the popularity of online surveys, or perhaps because of it, questions still arise that result from the specifics of electronic surveys. These questions mainly relate to methods of building questionnaires, reliability of collected data and ensuring anonymity of respondents. Among other important problems that should be paid attention to, researchers single out the following [7]:

- maximizing the number of completed surveys;
- effective encouragement of participation in research;
- avoiding mistakes and not giving answers to important questions;
- questions that raise sensitive topics.

In June 2023, we conducted an online survey of Ukrainian researchers to find out the attitude of the modern scientific community regarding the expediency of conducting online research (primarily in the psychological and pedagogical field) and determining the opinion regarding the reliability of the results

obtained in the process of these studies. Among the respondents, the total number of N=318, were persons from 25 to 65 years of age and older, with and without scientific degrees, whose scientific experience was from 5 to 30 years, the place of work was scientific institutions of the National Academy of Educational Sciences of Ukraine, higher educational institutions and institutions of professional preliminary education (colleges) [13]. The questionnaire contained 10 questions with closed and open answer options and the possibility to add answer options (<https://forms.gle/4JN39Xzmg973FNPa7>).

Among the survey participants, 35–50-year-olds predominated, their share was 35,6 %, approximately the same group represented respondents aged 25–30 (30,4 %) and 50–60 (30,9 %), a small age category was represented by persons aged 65 and over (Fig. 1). These are mainly candidates (34 %) and doctors of science (20,1 %), although the number of people without a scientific degree (27,3 %) and novice researchers who are currently conducting research or preparing to obtain a PhD scientific degree was quite large (18,6 %) (Fig. 2).

In our opinion, the list of problems that scientists are ready to investigate in an online format is an important indicator that indicates the inevitability of online research. The largest number of answers was collected by the option — studying the educational needs of various categories of people (67,8 %) and identifying learning difficulties (56,3 %). On the other hand, the least number of answers was collected by options regarding the formation of personality qualities (21,2 %) and determining the level of a foreign language (25,7 %) (Fig. 3) [13].

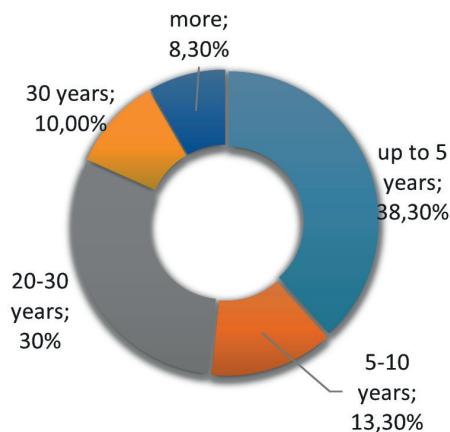


Fig. 1. Scientific and pedagogical experience

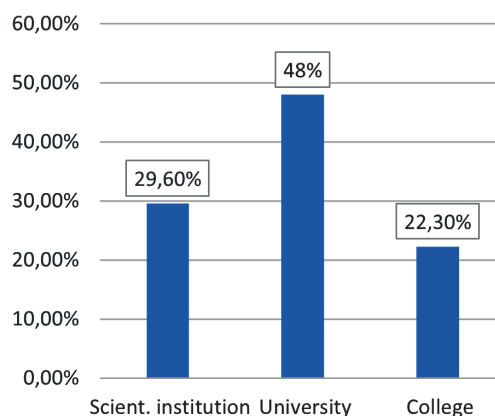


Fig. 2. The place of work of the respondents

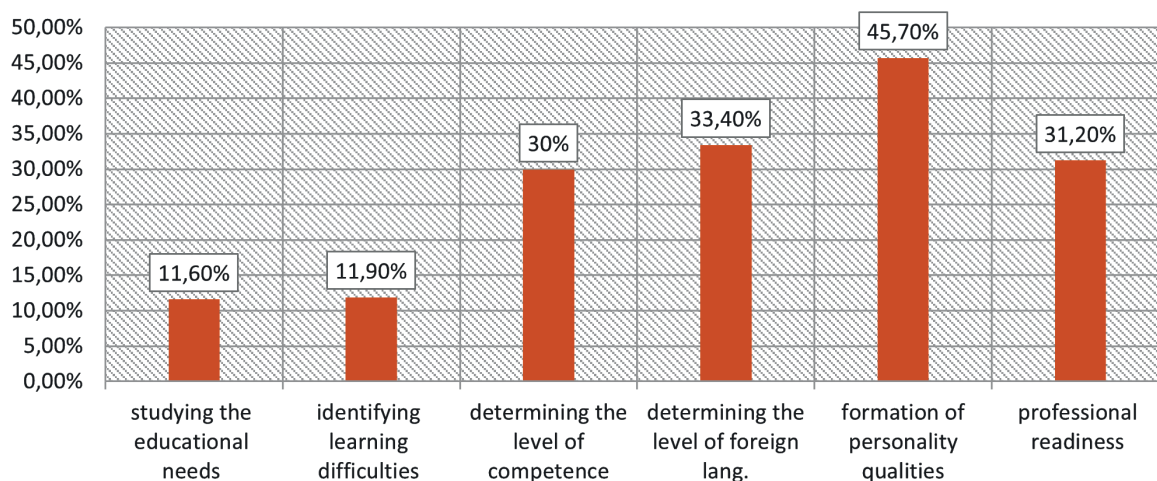


Fig. 3. Distribution of answers to problems that scientists are ready to investigate in an online format

Of course, the key aspect and driver of creating and conducting Internet research and surveys is the level of digital competence and the attitude towards the use of Internet resources and tools for searching and processing data. This key

aspect is related to the necessity and importance of learning the people’s experience of using Internet tools for work. The attitude towards the use of various tools offered by the Internet today can outline the picture of the popularity of certain online tools for different categories of people who are users of the global network.

Table 1

The use of online tools by teachers in comparison in 2021, 2022 and 2023 during distance and blended learning (source: [14])

Online tools	2021, %	2022, %	2023, %
Viber	83	78,4	77,7
Zoom	58,7	65,4	63,8
Google Apps for Education	15,1	20,2	53,1
e-diary	11,7	15,4	34,1
Learningapps.org	n. d.*	n. d.*	26,7
Telegram	13,8	13,3	26
Institution website	58,7	23,5	24,7
MyClass	20,7	19,5	22,1
Padlet	18,8	11	16,8
Kahoot	n. d.*	n. d.*	11,9
Skype	14	8,3	6,9
Microsoft Teams	4	4,7	4,9
WhatsApp	4	3,3	4,8
JitsiMeet	9,5	13,1	4,4
Moodle	4	3,2	3,8
Mentimeter	n.d*	n.d*	3,8
Tik-Tok	4	1,4	2,9

* n. d. — no date.

An example of opinion research on the use of online tools for the organization of educational activities can be cited from several surveys conducted by the Institute of Digitalization of Education of the National Academy of Educational Sciences of Ukraine, which related to the survey of teachers on the use of ICT for the organization of the educational process in Ukraine. Although such surveys are not popular enough, as more teachers are assessed on their professional digital competencies for certification in the certification period, their attitudes towards the online tools they use in their work were obtained [14]. Comparing the results of 2021, 2022 and 2023, we note that teachers turn to Internet tools to organize the educational process, and most teachers use Viber, Zoom, Google Apps for Education, Electronic diary, Learningapps.org, Telegram, the website of the educational institution (from 77,7 % to 24,7 % in 2023) (Table 1).

These surveys indicate the growing level of digital competence of teachers and the existence of several unresolved problems related to access to the Internet and devices, the need to create high-quality online resources for conducting lessons, clarifying issues of online assessment, and others.

Overall, while powerful, online tools necessitate researchers to develop new skills in areas like data/privacy management, technology digital literacy and virtual collaboration. Emerging best practices aim to optimize while mitigating potential pitfalls.

Conclusions and prospects for further research. In modern research practice, especially in the field of political, socio-economic, psychological and pedagogical sciences, there is an active development of online research. Their relevance began to grow during the restrictions associated with the COVID-19 pandemic and the introduction of martial law. This is a modern and popular tool for experimenting, an important feature of which is its inevitability. Using both traditional and online research methods has its advantages and disadvantages, strengths and weaknesses. When conducting online research, there is always a problem of reliability and validity of the results, which are the consequences of human and methodological factors, some of which are practically difficult to eliminate. There is also a risk of receiving answers that do not correspond to the actual situation. However, such defects can also occur during traditional research. Therefore, it is advisable to combine online techniques with traditional ones, which allows you to avoid elementary methodological mistakes. However, this requires not only research competence but also methodological awareness and reliable analysis and interpretation of research results. The rise of the internet and digital technologies has profoundly transformed the scientific research landscape, necessitating researchers to adapt their methods and practices. While online tools have democratized access to knowledge, enabled global collaboration, opened new avenues for data collection, and facilitated science communication, they have also introduced novel challenges that demand careful navigation. Ensuring data quality, reliability, and credibility remains a paramount concern in online research. The abundance of information on the internet, including potential misinformation and biases, underscores the importance of critically evaluating sources and employing robust verification measures. Additionally, safeguarding privacy and security when handling sensitive research data and participant information is a critical ethical and legal obligation.

The digital divide, characterized by uneven global access to internet infrastructure and technologies,

poses the risk of sampling biases in online studies. Researchers must be cognizant of these disparities and strive to ensure inclusive and representative sampling approaches. Furthermore, the rapidly evolving nature of online tools, platforms, and practices necessitates continuous learning and adaptation from the scientific community.

Ethical considerations, such as informed consent, anonymity, and compliance with evolving regulations, demand heightened vigilance in online research involving human subjects. Unique challenges like replicating browsing experiences and accounting for technological variations can hinder the reproducibility of certain online studies, prompting the need for transparent reporting and standardized methodologies. Despite these challenges, the internet has become an indispensable tool for scientific research, reshaping the landscape and offering unparalleled opportunities for collaboration, data access, and dissemination of findings. Developing best practices, honing new skills in areas like data management, technology literacy, and virtual collaboration, and striking the right balance between capitalizing on the internet's potential and mitigating its pitfalls will be crucial for advancing scientific inquiry responsibly and ethically in the digital age. The ways that researchers can address the challenges posed by the digital divide when conducting online studies are the following:

- multi-mode data collection: Combine online data collection methods with traditional offline approaches like in-person interviews, paper surveys, etc. This hybrid approach can help reach populations with limited internet access;
- provide access: Set up data collection stations or computer kiosks in community centers, libraries, schools etc. in underserved areas to allow those without personal devices/internet to participate;
- mobile-friendly surveys: Optimize online surveys for mobile devices like smartphones which have wider penetration than computers in many developing regions;
- over-sample underrepresented groups: Actively over-sample populations with limited connectivity when recruiting participants to ensure their inclusion in sufficient numbers;
- partner with community organizations: Collaborate with local organizations, community leaders, and trusted sources to raise awareness and encourage participation from disadvantaged groups;

- provide incentives: small incentives like mobile data packages or prepaid internet cards can help defray participation costs for disadvantaged groups;
- utilize alternate internet access: explore providing portable Wi-Fi hotspots or subsidizing public internet access in underserved areas during the study period;
- training and digital literacy: o basic digital skills training to participants unfamiliar with online tools as part of the research process;
- disaggregate data: analyze and report data disaggregated by demographic factors linked to the digital divide like income, education, urban/rural location, etc.;
- localize content: translate surveys into local languages and tailor content/examples to be contextually relevant for different populations.

The key is employing a multi-pronged strategy tailored to the specific study population to improve inclusion and representativeness when leveraging online research methods. Continuous monitoring of participation rates across groups is also crucial.

As the integration of online tools in research continues to deepen, fostering interdisciplinary collaborations and knowledge-sharing will be vital. Researchers from diverse fields, including computer science, statistics, ethics, and the social sciences, can contribute invaluable perspectives and expertise to address the methodological, technical, and ethical complexities of online research. Ultimately, the scientific community must embrace a proactive and adaptive approach, continuously refining online research practices and methodologies to uphold the highest standards of rigour, transparency, and ethics. By leveraging the power of the internet while remaining cognizant of its limitations, researchers can unlock new frontiers of discovery and advance the collective pursuit of knowledge for the betterment of society.

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ВИВЧЕННЯ ПОТЕНЦІАЛУ НАУКОВИХ ОНЛАЙН-ДОСЛІДЖЕНЬ ДЛЯ ЗАДОВОЛЕННЯ СУЧАСНИХ ПОТРЕБ: МІЖНАРОДНІ ПЕРСПЕКТИВИ

Анотація. Інтернет та цифрові технології трансформували ландшафт наукових досліджень, поклавши початок зміні наукової парадигми. У статті розглядаються способи впливу інтернету на полегшення виконання наукових досліджень, досліджуються внутрішні проблеми й обмеження, з якими стикаються дослідники в період цифровізації. Наведено приклади досліджень і ставлення різних категорій респондентів до використання онлайн-засобів. Онлайн-інструменти для співпраці вийшли за географічні межі, сприяючи глобальній командній роботі, обміну даними в реальному часі та міждисциплінарній синергії, відповідно і науковому прогресу. Це дало змогу дослідникам отримати доступ до великих баз даних, журналів і репозиторіїв, прискорити перегляд літератури, бути в курсі останніх наукових розвідок. Інтернет полегшив обмін дослідницькими даними, кодами і матеріалами, сприяючи прозорості, тиражуванню та повторному використанню цінних наукових ресурсів. Проте цифрова трансформація не позбавлена проблем.

Якість, надійність і достовірність даних є найважливішими серед них, оскільки онлайн-інформація може містити помилки або навіть навмисну дезінформацію. Цифровий розрив і нерівномірний глобальний доступ до інтернет-інфраструктури можуть призвести до упередженості вибірки в онлайн-дослідженнях. Отже, у статті висвітлено переваги та недоліки використання онлайн-інструментів для здійснення досліджень. Поява нових онлайн-інструментів, платформ вимагає їхньої постійної адаптації, а такі чинники, як унікальний досвід вебперегляду та технологічні варіації можуть перешкоджати відтворенню певних онлайн-досліджень. Попри ці виклики автори стверджують, що інтернет став незамінним інструментом для наукових досліджень, змінюючи ландшафт і створюючи як можливості, так і проблеми, в яких наукове співтовариство має вміло орієнтуватися. Новизна статті полягає у представленні кращих практик щодо вдосконалення нових навичок у таких сферах, як керування даними, цифрова грамотність, віртуальна співпраця, що мають вирішальне значення для відповідального й етичного просування наукових досліджень у цифрову епоху.

Ключові слова: онлайн-дослідження; інформаційне суспільство, дослідження; інтернет; точність, надійність, технології та методи дослідження.

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