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Determination of digital technologies preferences of educational researchers

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Abstract

Purpose – This study aims to investigate the preferences of 96 educational researchers on the use of digital technologies in scientific research.

Design/methodology/approach – The study was designed as a quantitative-dominant sequential explanatory mixed-method research.

Findings – Despite the spreading use of advanced technologies of big data and data mining, the most preferred digital technologies were found to be data analysis programs, databases and questionnaires. The primary reasons of using digital technology in scientific research were to collect data easily and quickly, to reduce research costs and to reach a higher number of participants.

Originality/value – The use of digital technologies in scientific research is considered a revolutionary action, which creates innovative opportunities. Through digitalized life, probably for the first time in history, the educational researchers have analytical information, which we can benefit from more than the individual's own statements in research involving human factor. However, there are a few studies that investigated the preferences of educational researchers who use digital technologies in their scientific research.

Keywords Digital technologies in scientific research, E-research, Educational researcher

Paper type Research paper

1. Introduction

In the early 1990s, the use of internet gained momentum through its application in scientific research, intercollegiate data sharing and related projects, especially in Europe (Dutton and Meyer, 2009). Continuously enhanced by Web and internet applications, new technological tools have been considered as a revolution for scientific research (Dutton, 2013) because they allow quicker, easier and more comprehensive research access. CERN and Human Genome Project can be pointed out as some of the first examples for the scientific use of these digital technologies.

The use of digital technologies in scientific research has become an important and effective way for researchers (Topp and Pawloski, 2002). Thanks to digital technologies, more data can be accessed rapidly and easily, which necessitates benefiting from digital technologies to achieve meaningful results from large data sets. Digital technologies can be used not only to obtain big data but also to access larger sample sizes. The advances in digital technologies have expanded the capacity and scope of scientific research methodology.

Before the invention of World Wide Web (WWW), Kiesler and Sproull (1986) discussed the possibility of using computers to collect data in social sciences. Even if they were optimistic about its potential, they also warned that "electronic research is probably not possible until

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computers and networks are spread all over the community." Nowadays, considering the progress of the internet and computers, it seems possible to take advantage of the potential benefits pointed out by Kiesler and Sproull (Gosling *et al.*, 2004).

The idea of quantifying data through computers in social sciences has a long history. From the late 19th century to the middle of the 20th century, the development of quantitative data and analytical tools in social sciences was crucial to ensure and acknowledge social sciences as legitimate academic discipline. In this period, the emergence of analytical programs, such as SPSS, which are still very popular, had a revolutionary role in scientific research (Miller *et al.*, 2002). In addition to quantitative package programs, the qualitative programs, such as NVivo and NUD*IST, have made research more rigorous and transparent by completely changing the data collection and analysis processes (Dean and Sharp, 2006) and by reshaping some types of research like ethnography as well. The rise of digital technologies has also led to a new research method called virtual/digital ethnography (Murthy, 2008; Steinmetz, 2012), which is creating new qualitative research possibilities in ethnography.

1.1 Internet and research methods

Hypertext Transfer Protocol (HTTP) has created a new and exciting way to conduct research via the internet (Birnbaum, 2004). It has made 24/7 data collection possible from around the world for researchers. All kinds of electronically created data collection tools, such as questionnaires, tests, scales, assessment forms, can be sent to the target group on the Web in minutes. The data, collected by using these tools and rapidly delivered to anybody connected to the Web, can be automatically recorded without requiring any special hardware, paper, mailing costs and labor. The number of studies carried out with the help of these tools is increasing exponentially.

Today, researchers from all around the world can access scientific research data, work collaboratively in almost every field and share their data and research results on the internet. Individuals can express their opinions more openly and freely in online environments. According to Stanton and Rogelberg (2001), by allowing individuals to express their opinions openly and freely, this new environment brings a new dimension to scientific research. That is why, it has a potential to extend the boundaries of educational research.

Benefiting from online environments as a tool in scientific research has become an important and effective practice for scientists and researchers (Dutton, 2013; Topp and Pawloski, 2002). Online data collection conducted through e-mails and Web-based questionnaires has become such a popular research method (Granello and Wheaton, 2004) that new professional respondent groups who frequently participate in surveys for incentives have emerged (Buchanan and Hvizdak, 2009; Matthijsse *et al.*, 2015).

More recently, social media data analysis, big data analytics, Semantic Web technologies and learning analytics have come into prominence (Sambyal *et al.*, 2019). Electronic tools and applications have become popular for data collection, and the internet has become a popular data collection environment because the alternative question formats, alternative listing options and audio-visual support provided by digital technologies allow to develop various data collection tools and to use various designs (Best and Krueger, 2004; Namey *et al.*, 2020). However, perhaps more importantly, the internet is a huge newly discovered data source for researchers with its previously entered innumerable data.

1.2 Literature review

Unlimited data that have been stored for years on databases of the internet, and the ability to process these data within seconds via new metadata, ontologies and semantic data analysis technologies has created new and exciting opportunities for scientific

research (Garoufallou and Greenberg, 2019). In the related literature, the "e-research" concept is popular to describe the use of digital technologies in scientific research. "e-research is a rapidly growing area in many fields of scholarship, from the natural sciences to the humanities, as research moves online and becomes increasingly distributed across larger-scale and multi-institutional collaborations" (Meyer and Schroeder, 2009, p. 247). Markauskaite (2010) argues that e-research challenges the divide between "monological" and "dialogical" research and has a potential to create "trialogical" ways of scientific inquiry.

In their comprehensive study, Anderson and Kanuka (2003) focused on when and how electronic tools can be used in the development of a research process and stressed that e-research is not a method. Likewise, Wishart and Thomas (2015) focused on e-research from an educational perspective, where they analyzed the recently emerging digital methods. According to the findings of the study, the increasing use of multimedia and other visual learning tools has created multimodal opportunities in both teaching and research. According to Borgman (2006), e-research is intended to facilitate collaboration between researchers through distributed access to content, tools and services. Additionally, e-research has the potential to offer new insights into complex educational challenges (Markauskaite *et al.*, 2011).

Most of the studies in the related literature have emphasized the advantages of internet-related scientific research tools and environments. Stanton and Rogelberg (2001) conducted a study on the use of web pages in research data collection. In this study, a questionnaire was delivered via the WWW to the first group of 50 participants. The second group formed by 181 participants filled out the same questionnaire on paper. Analyses of the two data sets supported the viability of data collection through the WWW. In sum, networked, browser-based research is highly flexible and can take many different forms. Both any paper-and-pencil study can appear on a browser and the medium can also provide unique and new opportunities for a researcher. The findings obtained by Çakıroğlu (2007) showed that online questionnaires took shorter time (62%), had higher rate of response (71%), were taken more seriously (81%), were easier to use (83%) and enabled to answer without bias (69%). Prathap *et al.* (2011) researched the feasibility of conducting online surveys. They found that the rich resources and computer-supported communication opportunities on the internet contributed to the popularization of online questionnaire applications. Similarly, according to Dillman (2000), administering questionnaires in traditional ways such as phone, mail or face-to-face was both expensive and open to errors due to low rates of response.

In their study, Nosek *et al.* (2002) discussed the ethics, security, design and control dimensions of e-research, and underscored the unique opportunities the internet provided for researchers in their individual and group projects. By using digital technologies, chat room messages can be analyzed to test research hypotheses regarding individual or group behaviors or to easily determine individual or group reactions to the historical phenomena such as wars or elections. Moreover, researchers do not have to wait for months to do this because it is possible to access plenty of data through existing archives. Various types of traditional research (questionnaires, experimental research, observations and interviews) can also be conducted on the internet. Birnbaum (2004) has observed that a researcher can collect data singlehandedly, efficiently and quickly about big heterogeneous and rare samples via the WWW, and it facilitates the replicability of the study by standardizing the procedures. Based on the historical evolution of science, Meyer and Schroeder (2009) have re-conceptualized e-research by reporting on the effectiveness, scale and coverage of e-research in various studies, which allows e-research to be examined through multiple lenses to understand how the information in the e-research field is generated and obtained.

The related literature also provides useful studies on strategies to benefit from digital technologies in scientific research. With the participation of 81 academics, Bhatti (2013) studied the use of digital technologies by academic staff and found that they frequently used the internet technologies in their teaching and research. Keusch (2013) investigated the

influence of personal interest and the topic of online Web surveys on participation behavior and the quality of collected data. S/he found that personal interest in the topic had an impact on participation behavior and the quality of collected data. Participants are willing to participate if the topic of the survey was announced in advance.

Even though majority of the literature has supported the use of digital technologies in scientific research, there are also some reservations and criticism. Bosnjak and Batinic (2002) have questioned the reason why people might not wish to participate in surveys or to answer all items online. Their study has showed that factors such as completing in a short time, being interesting and containing explanatory information affect the participation in the survey. Welker (2001) stressed that surveys sent via regular mail had higher response rates than electronic surveys. The reason is that people do not really care about the e-mails that come from someone they do not know. In addition, Nosek *et al.* (2002) have underlined the difficulties of participation control, data security and ethical issues in internet research. In an experimental study, Keusch (2013) has observed that online invitations to fill out Web surveys do not provide sufficient and clear information about the application, scope and even the topic of the survey to reduce the risk of bias. In a repeated-measure design research, Akbulut (2015, p. 131) investigated the antecedents of inconsistent responses in Web surveys. The findings based on the data collected on Facebook with 806 respondents showed that "45.7 percent of the participants misreported their personal information such as age, educational status and gender." Another concern in online research is the emergence of professional respondents. In their critical study, Matthijsse *et al.* (2015) have investigated if professional respondents can be distinguished in online panels and if they provide lower-quality data than non-professionals. The results of the research have showed that these professional respondents, who frequently participate in surveys especially for the incentives, are not a great threat to data quality. In the survey they conducted with 750 participants working in university Human Research Ethics Boards (HRECs), Buchanan and Hvizdak (2009) have found that electronic, Web or online surveys threaten traditional ethics of consent, risk, privacy, anonymity, confidentiality and autonomy and lead to methodological confusion such as data storage, security, sampling and survey design.

1.3 Problem statement

Some popular digital technologies used in the field of educational research are Web 2.0, online questionnaire applications, web analytics, computer logs and package programs such as Lisrel and NVivo. The use of digital technologies in scientific research has not only expanded the research scope, but also brought new approaches like learning analytics, big data analyses and social network analyses. However, although the use of digital technologies is increasing in educational research, this new research network and tools remain an important issue of discussion on scientific research agendas. There are several studies on the use of specific digital technologies and contributions of these digital technologies to educational research. Some of these studies are listed in Table 1.

As can be seen in Table 1, although there are some studies in the related literature about the use of various digital technologies in educational research, the digital technologies commonly used by educational researchers and their views on using these information and communication technology (ICT) tools have not been adequately and comprehensively studied so far.

The literature review has also revealed various studies about ICT-assisted research, which mostly focus on the opportunities provided by digital technologies (Bhatti, 2013; Birnbaum, 2004; Wishart and Thomas, 2015), how this kind of research can be conducted and how they differ from traditional research (Anderson and Kanuka, 2003; Karpf, 2012). However, our in-depth literature review has showed that despite the intensive use of ICT, particularly in

Studies	Research subject	Sample size	Method	Findings
Akbulut (2015)	Predictors of inconsistent responding in Web surveys	A repeated-measures design was conducted with 806 respondents in two online survey administrations	Quantitative	45.7% of participants misreported their personal information such as age, educational status and gender in Web survey
Keusch (2013)	Role of topic interest and topic salience in online panel Web surveys	Data about the personal interests of 1,660 panel members were collected	Quantitative	Evidence is presented that personal interest in the topic influences participation behavior and data quality in online panels. Panelists who had been enrolled in the online panel for six months or less were more willing to participate if the topic of the survey was announced in advance
Bhatti (2013)	Internet and internet technologies in research	Data 100 faculty members (teachers) were collected	Descriptive research	The findings show that the internet has become a significance source for the faculty members and researchers as they use the internet for education purposes, research work and updating knowledge. Google, Yahoo and MSN are widely used search engines and majority of the respondents do not use the Excite, Snake, Kapok and Alta vista
Prathap *et al.* (2011)	Feasibility of conducting online surveys	–	Descriptive research	Online surveys provide great methodological potential and versatility for data collection. Online communication research raises a number of complex issues for the researchers, respondents and policy makers. In India, certainly, Web survey methodology is still in its infancy
Çakıroğlu (2007)	Advantages of online questionnaires	320 online survey participants and 320 traditional survey participants participated in the study	Quantitative	According to the findings, the online survey was completed in a shorter time, (62%), response rate was higher (71%), it was taken more seriously (81%), it was easy to use (83%) and it allowed answering without bias (69%)

Table 1.
Literature on the use of digital technologies in educational research

(*continued*)

Studies	Research subject	Sample size	Method	Findings
Birnbaum (2004)	Collect data via the WWW	–	Web-based research	Programs and instructional materials are now available to make it relatively easy for a new investigator in this field to be able to implement simple studies to run via the WWW. Investigators who have begun research using these techniques have for the most part judged the method to be successful and plan to continue research of this type. Although some methodological problems have emerged in Web-based research because of the lack of control in Web studies, many investigators consider the advantages in experimental power, low cost and convenience of testing via the Web to outweigh its disadvantages
Nosek *et al.* (2002)	Ethical, security, design and control dimensions of e-research	–	Web-based research	Internet-based research is the increased opportunity for participant misbehavior, intentional or otherwise

Table 1.

educational research, the researchers' opinions on the use of digital technologies in research have not been investigated adequately. Nevertheless, to be able to determine and develop the potential of using digital technologies in scientific research, the approaches, preferences and suggestions of people using digital technologies in practice must be identified first. Also, researchers' attitudes should be critically reviewed. Therefore, this study is expected to contribute to the literature by filling this gap.

1.4 Research goal

The aim of this research is to determine the preferences and opinions of educational researchers about the use of digital technologies in scientific research. With the current study, researchers are also presented with recommendations for conducting more effective and efficient research with digital technologies. In line with this purpose, this study seeks to find out the preferences, opinions and suggestions of educational researchers; to identify the profile of researchers that use digital technologies in their research; and to determine the effect of using ICT in scientific research.

To achieve the aim of this research, the following research questions have been determined:

(1) What are the digital technologies that educational researchers use in their research?

(2) What are the advantages of using digital technologies in scientific research for educational researchers?

(3) What are the disadvantages of using digital technologies in scientific research for educational researchers?

(4) What are the suggestions of educational researchers using digital technologies in scientific research?

(5) What are the predictions of educational researchers using digital technologies in scientific research?

2. Methodology

This study is designed as a quantitative-dominant sequential explanatory mixed-method research. What makes the mixed-method research stronger than the solely quantitative or solely qualitative research is its balancing out their inherent limitations (Gibson, 2017). As a research design of mixed-method research, quantitative-dominant sequential explanatory analysis is common and useful for educational evaluation and policy studies (Ivankova *et al.*, 2006; Miller and Frederic, 2006). The data for the present study were collected in two steps, by first collecting the quantitative and then the qualitative data. The mixed method is used while searching for answers to research questions that cannot be answered by qualitative or quantitative research methods alone. However, distinctive features of the mixed-method research, such as pluralism and selectivity, can often make the mixed method superior compared to single-method designs (Johnson and Christensen, 2004). For these reasons, it is preferred to use mixed method in the study.

2.1 Data collection process

The e- Research Profiles Questionnaire (e-RPQ) used in the data collection process was firstly transferred into an electronic environment. The questionnaire questions and items were converted into online questionnaire items (radio button, drop-down list, Likert), and the necessary revisions were made. The six steps taken in the data collection process are given in Figure 1.

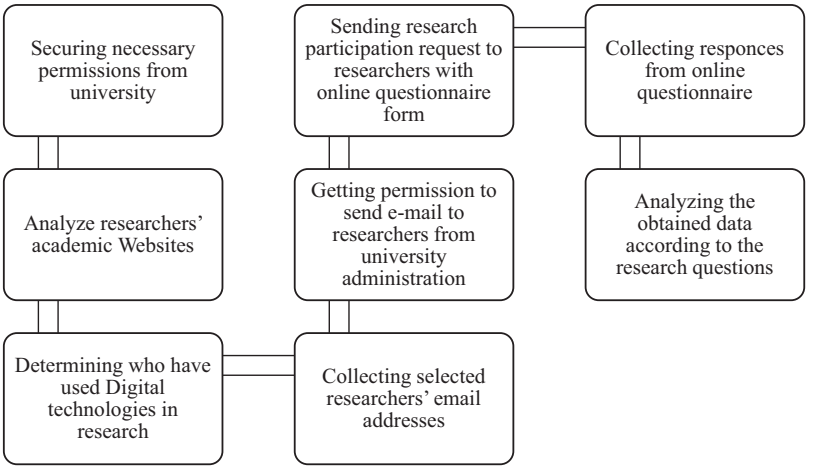

Figure 1.
Data collection process

As shown in the figure above, in the data collection process, first, the required permissions were obtained from the universities. Subsequently, the research group was determined by following the purposeful sampling procedures. A volunteer participation request e-mail including the online questionnaire link was sent to the determined research group. Only the institutional e-mail addresses of the researchers were used for these messages.

2.2 Sample

E-mails were sent to 132 researchers, and 93 of them responded. The response rate was 70.45%. As purposeful sampling was used in the determination of the research group, only those researchers using digital technologies in their research were asked to answer the questionnaire. The demographic information about the participants is given in Table 2.

It is striking that 882% of the participant researchers are under 40, and 75.3% consider themselves as advanced technology users. However, it should be noted that the research group consists only of educational researchers who use digital technologies in their research. Participants were from six education faculties in different universities.

The standardized open-ended interview form was also transferred to online. This form was sent to 93 researchers who participated in the study; 49 researchers answered the interview form.

2.3 Data collection tools

e-RPQ form developed for the study was used as the data collection tool. The first draft of the questionnaire form was derived from the literature review. The form aimed at educational researchers, was then submitted to six field experts for its face and content validity to be

	Demographics	Frequency (*f*)	Percent (%)
	Gender		
Questionnaire	Female	29	31.2
	Male	64	68.8
	Age		
	20–29	38	40.9
	30–39	44	47.3
	40+	11	11.8
	Academic title		
	Non-PhD	68	73.1
	phD	25	26.9
	Technology use		
	Normal	23	24.7
	Advanced	70	75.3
Interview	*Gender*		
	Female	20	40.8
	Male	29	59.1
	Age		
	20–29	15	30.6
	30–39	25	51.1
	40+	9	18.3
	Academic title		
	Non-PhD	21	42.8
	PhD	28	57.2
	Technology use		
	Normal	13	26.5
	Advanced	36	73.5

Table 2.
Demographics of participants

checked. Necessary corrections to the questionnaire were made by following the experts' suggestions. Irrelevant items were removed, similar items were merged and some new items were added where necessary. The piloting of the final version of questionnaire form was conducted with eight researchers. This piloting has showed that it takes 12 min on average to answer the questionnaire. The questionnaire was then revised based on the piloting results. The final form of e-RPQ consists of three sections. In the first section, there are five questions regarding demographic information such as age, gender, academic title and technology use. In the second section, there is an eight-item five-point Likert-type question about electronic tool and environments for data collection purposes. In the last section, there is a ten-item five-point Likert-type question about the reasons for using electronic tool and the scientific research environments. The qualitative data were collected via an open-ended interview form. To collect qualitative data, a standardized open-ended interview form was prepared. The most important feature of standardized interview forms is that the same questions are in the same order in all interview forms. Thus, the answers given by the respondents can be easily compared (Fraenkel and Wallen, 2006). This form includes four standardized questions about advantages, disadvantages, suggestions and recommendations of researchers on the use of digital technologies in scientific research. Thanks to these interviews, the findings obtained within the scope of the study were detailed. In other words, the findings obtained in the quantitative part of the study were supported.

2.4 Data analysis

In this study, the data analysis process was carried out according to the explanatory mixed-method research procedures. Thus, firstly, the quantitative data analysis was performed, and then the qualitative data elicited from the researchers' opinions were analyzed. The steps of data analysis process are given in Figure 2.

In this study, both quantitative and qualitative data were collected through e-RPQ. The quantitative data were collected through the questionnaire, and the qualitative data were collected through the standardized open-ended interviews. In the analysis of quantitative data, SPSS 23 package program was used. Independent samples *t*-test and one-way ANOVA were used as the parametric tests in the analysis of the obtained quantitative data, in addition to the %, *f*, Sd, *N* and $\bar{X}$ descriptive statistics. To find out which groups differ significantly, one of the most common *post hoc* (multiple comparisons) tests, Bonferroni, was used.

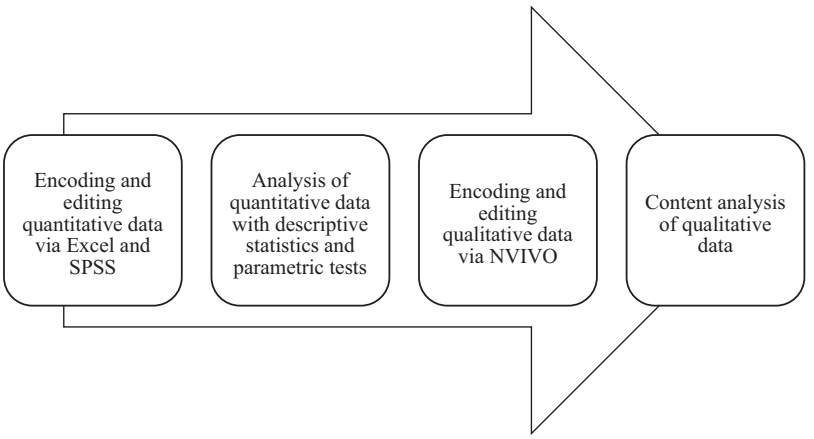

Figure 2.
The data analysis process

Bonferroni is a popular multiple comparisons test that does not require equal sample sizes (Miller, 1977).

Inductive content analysis was used for the qualitative data analysis. Inductive content analysis is a method that requires an in-depth analysis of the data, allowing to discover new themes, dimensions, concepts and correlations (Marsh and White, 2006). Researchers' opinions about the use of digital technologies in scientific research were transcribed and then transferred to NVivo package program for data analysis. In the direct quotes, pseudonyms like A1, A10 and E1, E2 were used to protect the participants' anonymity.

3. Findings

3.1 Quantitative findings

3.1.1 Digital technologies that educational researchers use in their research. In accordance with the sequential explanatory mixed-method design, the findings obtained from the quantitative data analysis are presented first, followed by the presentation of the findings obtained from the qualitative data analysis, aiming to support the quantitative findings. To find out which electronic environment and tools are used by researchers in their scientific research, a ten-item five-point Likert-type question in the second part of the questionnaire was used. "How often do you use the given tools and environments in your scientific research? (Never = 1, Rarely = 2, Sometimes = 3, Often = 4, Always = 5)." The means of the answers given for this question are given in Figure 3.

Figure 3 shows that the highest mean belongs to data analysis programs; however, three-dimensional (3D) virtual worlds item has the lowest mean. This finding indicates that, while the traditional data analysis programs are still the most frequently used tools, ICT-using researchers have begun to use new e-research technologies such as social web applications, videos, games and simulations. Based on the researchers' demographics, the details about the digital technologies they use are given in Table 3.

As shown in Table 3, it has been revealed that the reasons given for use of digital technologies in scientific research differ in demographics. To find out whether the reasons for using digital technologies in research differed statistically significantly for the educational researchers in their demographics, independent samples *t*-test and one-way ANOVA were used. The analyses indicated that the reasons for use of digital technologies did not have a significant difference based on researchers' titles and the level of technology use. However, significant differences were found in reasons of "ensuring voluntary participation" [$t_{(93)} = 2.187$, $p = 0.031 < 0.05$] and "reducing data loss" by gender [$t_{(93)} = -2.284$, $p = 0.025 < 0.05$] and in the "reducing research cost" reason by age [$F_{(2,\ 90)} = 3.48$, $p = 0.035 < 0.05$]. It was also determined from which group the significant differences in "ensuring voluntary participation" and "reducing data loss" reasons by gender resulted.

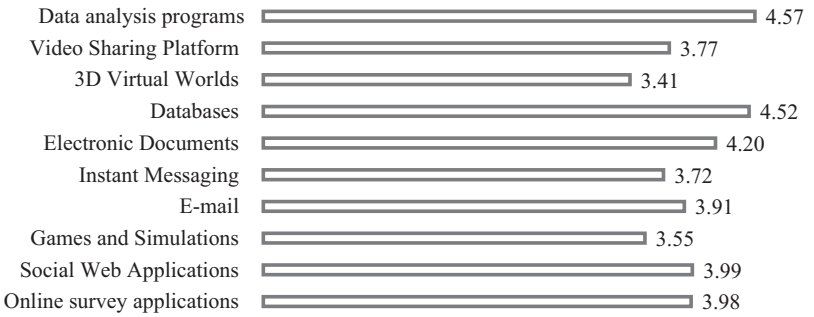

Figure 3.
Digital technologies used by educational researchers in their research

Table 3.
Digital technologies used according to participant demographics

Demographics		Online questionnaire	Social web	Games and simulations	e-mail	IM	e-documents	Database	3D VW	Video	Software
Gender	Female	4.24	4.24	3.52	3.93	3.62	4.34	4.59	3.55	3.69	4.62
	Male	3.86	3.88	3.56	3.91	3.77	4.14	4.48	3.34	3.81	4.55
Age	20–29	4.13	4.13	3.79	3.87	3.74	4.21	4.55	3.61	3.92	4.53
	30–39	3.93	4.05	3.43	3.93	3.73	4.20	4.52	3.23	3.73	4.55
	40+	3.64	3.27	3.18	4.00	3.64	4.18	4.36	3.45	3.45	4.82
Title	Non-PhD	4.01	4.04	3.57	3.81	3.66	4.15	4.49	3.40	3.78	4.49
	PhD	3.88	3.84	3.48	4.20	3.88	4.36	4.60	3.44	3.76	4.80
Technology use	Normal	3.61	3.74	3.43	3.91	3.70	4.30	4.48	3.30	3.91	4.48
	Advanced	4.10	4.07	3.59	3.91	3.73	4.17	4.53	3.44	3.73	4.60

According to the findings, the female researchers viewed both ensuring voluntary participation ($\overline{X} = 4.31 \geq \overline{X} = 3.84$) and data loss reduction ($\overline{X} = 4.14 \geq \overline{X} = 3.58$) more as reasons to use digital technologies than the males did. The Bonferroni test was used to identify which groups differed significantly for the reasons of using digital technologies by their ages. This test demonstrated that researchers in the 30–39 age group supported the research cost reduction reason significantly more than the researchers aged 40 and over.

3.2 Qualitative findings

In accordance with the explanatory mixed-method design, further qualitative data were collected and analyzed to explain the quantitative data findings. Four questions of standardized interview represent the four categories of themes. The participants' opinions about the use of digital technologies in scientific research were subjected to inductive content analysis. For that purpose, the raw text in the NVivo program was coded and analyzed, yielding a total of 22 themes. These themes were grouped under four pre-defined groups as advantages, disadvantages, suggestions and predictions.

3.2.1 Advantages of using digital technologies in scientific research. The opinions regarding the advantages of using digital technologies in scientific research include nine themes. These themes are given in Figure 4.

The numbers on the arrows indicating the relationships among the themes in Figure 5 have showed how many times each sub theme is repeated in the interview data. The most

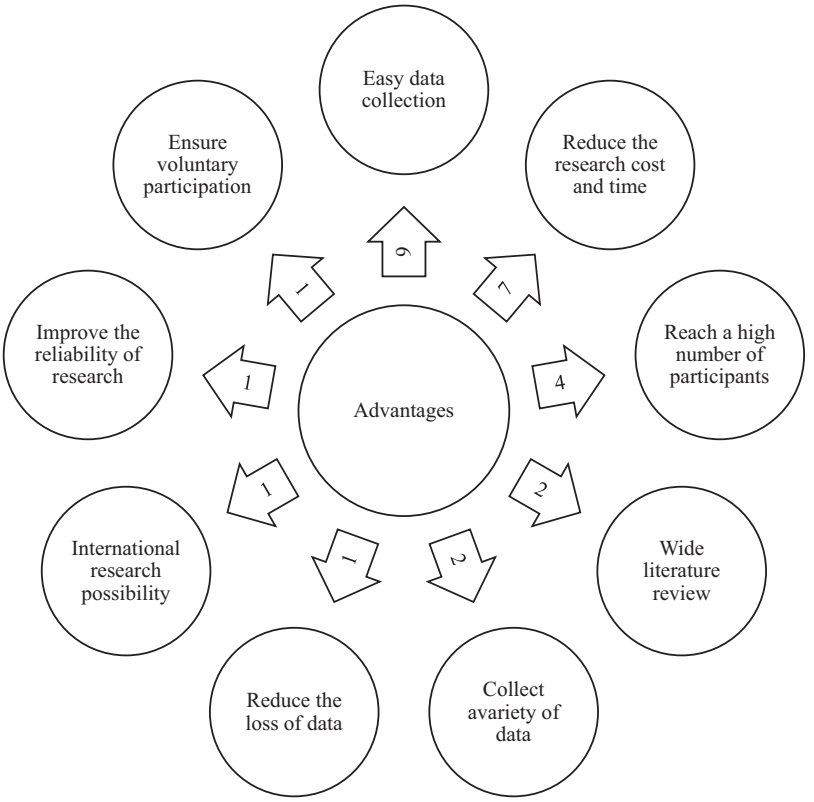

Figure 4.
Advantages of use of digital technologies in scientific research

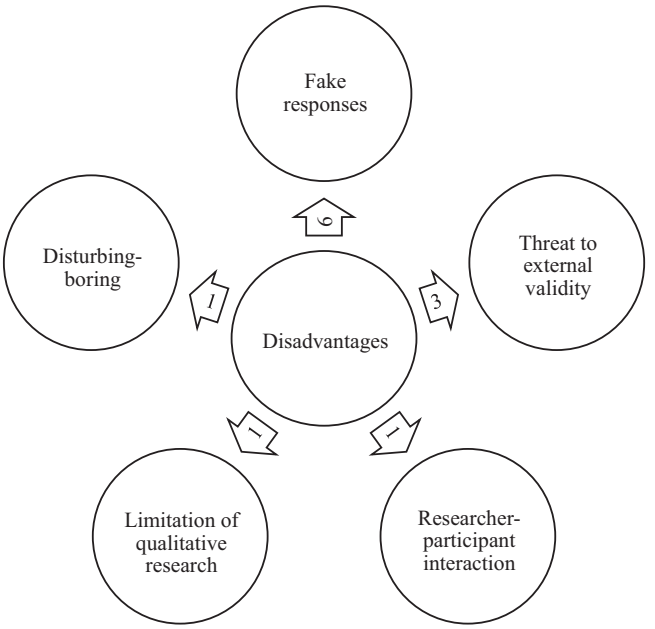

Figure 5.
Disadvantages of use of digital technologies in scientific research

often repeated advantage by the researchers regarding the use of digital technologies in scientific research was easy data collection. This advantage was followed by reducing the research cost and time and reaching a high number of participants. A direct quote as expressed by one of the researchers about easy data collection is as follows:

> . . .I think it is useful and necessary to use electronic media to collect data for scientific research. Especially with the appearance of mobile technologies (smart phones, tablets) data collection has become much easier and quicker. We need to benefit from such opportunities offered to us by technology (R11).

3.2.2 Disadvantages of using digital technologies in scientific research. While strongly underscoring the advantages of digital technologies, the researchers participating in the study also listed some disadvantages of using digital technologies in scientific research. The participants' opinions regarding the disadvantages were grouped into five themes. These five themes are presented in Figure 5.

As can be seen in Figure 6, the most often reiterated disadvantage of using digital technologies by the participants was "fake response." This was followed by the threat to external validity. Direct quotes from two researchers about "fake response" is given below:

> . . .Data may be collected quickly. However, the problem of reaching real people needs to be resolved. This is a factor that cripples research reliability (R7).

> . . .Its limitation is; its vagueness as to what extent it is meaningfully answered upon full comprehension (R41).

As can be seen from the quotes above, researchers drew attention to the risk of fake response problem that may result from the use of digital technologies in scientific research, due to random and irrelevant answers and fake information given.

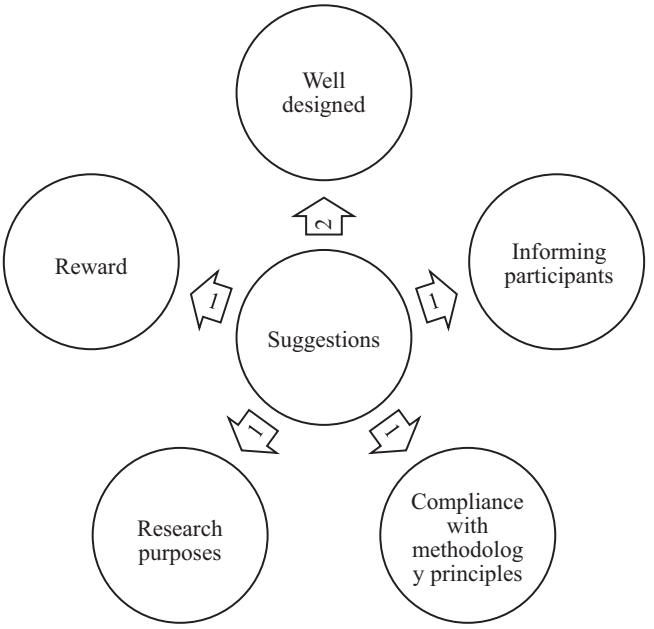

Figure 6.
Suggestions for use of digital technologies in scientific research

3.2.3 Suggestions for use of digital technologies in scientific research. Researchers also made some suggestions about using digital technologies in scientific research. The themes with these suggestions are given in Figure 6.

As can be seen in Figure 6, researchers had five main suggestions regarding the use of digital technologies in research, the foremost of which is proper design. A direct quote regarding proper design is as follows:

> . . .Questions should be simple and intelligible. There should be as many open-ended questions as possible. The number of questions should be small. For example, there should be smaller than 30 questions (R30).

As can be seen in the direct quote above, when collecting data in an electronic environment, the researchers stressed the need to make data collection tools plain and simple. In a similar way, researchers suggested that the decision about whether to collect data via electronically or via paper-based medium should depend on the purpose of the planned research; the data collection process should be carried out according to scientific research methodology, and electronic data collection tools should be informative. Additionally, it was also suggested that research participants could be given rewards during the data collection process in electronic environments to ensure their interest and motivation.

3.2.4 Predictions for e-research. Researchers also made some predictions about the use of digital technologies for research. Grouped in three themes, the predictions are presented in Figure 7.

As can be seen in Figure 7, the participants made three basic predictions regarding the future of e-research: e-research will form a new research community in time; it will rapidly spread (popularization) in scientific circles; and it will yield rich data in the near future. A direct quote from a researcher is as follows:

> . . .I believe that e-research will have a richer potential with more diverse tools in the future (A15).

4. Discussion

The quantitative data have revealed that the most used digital technologies are traditional data analysis programs and databases. Apart from this, although data analysis software is the mostly used tool, it has been found that current e-research technologies like social web applications, 3D virtual worlds, games and simulations have also become widespread. This finding is supported by Prathap *et al.* (2011) who have stated that the use of new digital technologies in scientific research is becoming popular. Bhatti (2013) has also supported this finding by indicating that internet technologies have begun to be extensively used in social science research. Besides, Nosek *et al.* (2002) have indicated that within the context of e-research, the internet is becoming an effective resource not only for experimental and quasi-experimental research but also for other research methods, including natural and archival research, interviews or participant observations. King *et al.* (2014) proved that social networks could be used as a fast and cost-effective data collection tool. According to Murthy (2008), social researchers cannot afford to continue this trend.

According to their demographics, the digital technologies used by the researchers were compared with parametric tests. The results of the analysis have revealed that data analysis programs are more often used by PhD researchers than non-PhD researchers, and online questionnaire applications are used more frequently by the advanced technology users. The reason why PhD researchers use data analysis programs more frequently might be that data analysis software requires a certain level of expertise. Furthermore, it has been identified that researchers at the age of 20–29 use a significantly higher number of social web applications compared to researchers being 40 or over. In recent years, young adults have been spending more and more time on social network sites whose popularity has increased tremendously (Ehrenberg *et al.*, 2008; Hargittai and Hinnant, 2008; Wilson *et al.*, 2010). The reasons for this might be that young researchers are more active in and familiar with social web environments.

The analysis of the researchers' reasons for using digital technologies in their research revealed four main purposes: easy data collection, quick data collection, reducing research costs and reaching more participants. This finding supports Nosek *et al.*'s (2002) finding that a great amount of data can be reached and analyzed with the help of digital technologies, Çakıroğlu's (2007) finding that online questionnaire application can be concluded in a short time and Dillman's (2000) finding that traditional research is more expensive. Gibbs (2002) emphasizes that the development of package analysis programs such as NVivo and Atlas.ti helps to reduce the resources required for the overall analysis of data and is useful for quick and easy handling of large data sets collected in research. Granello and Wheaten (2004) list the advantages of online data collection tools while paying a particular attention to the falling costs. It is emphasized that ICT-supported tools reduce the costs of traditional methods. It is important for researchers to reduce the financial burden on traditional data collection tools such as printing, postage or stationery costs. In their study comparing online data collection with traditional paper/pencil techniques, Ward *et al.* (2014) reported that the factors of financial savings and easier access to large populations made ICT-supported research superior.

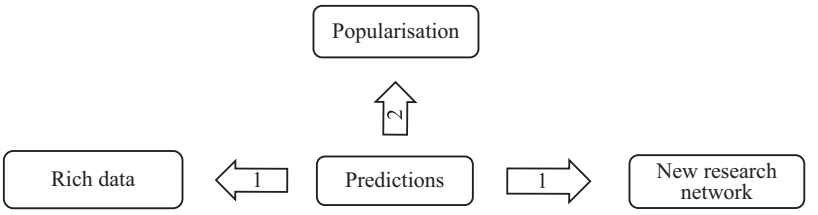

Figure 7.
Predictions for e-research

The reasons stated by the researchers for their use of digital technologies were compared by using parametric tests regarding their demographic information. The result of the analyses showed that compared to the male researchers, the female researchers more strongly supported both ensuring voluntary participation and reducing data loss. Moreover, compared to the researchers at the age of 40 and over, the support given by the 30–39 age group for the rationale of reducing research cost was more significant. This difference may have resulted from younger researchers' financial status, a finding also supported by Duisenova (2015). Friesenhahn and Beaudry (2014) further emphasize that young researchers' financial status forces them to seek alternative cheaper methods, which needs to be remedied.

Researchers' opinions on using ICT in scientific research were analyzed in accordance with the explanatory mixed-method design. A total of 22 themes were formed as a result of the content analysis conducted via NVivo package program, and these themes were subsumed under four main pre-determined headings as "advantages, disadvantages, suggestions and predictions." Based on their recurrence frequency, the most frequently occurring advantages of using digital technologies in scientific research mentioned by the researchers were: easy and fast data collection, reducing the research cost and time and reaching a high number of participants. This finding is parallel to researchers' answers to the second research question.

As for the disadvantages of using digital technologies in scientific research, the most common themes reported were "fake response" and "threat to external validity." Disadvantages appear to mostly stem from the unestablished technology-based research culture. These findings about the advantages and disadvantages of the use of digital technologies in scientific research indicate that researchers stress the advantages of using digital technologies more often. Different from this study, Wright (2005) cites the disadvantageous aspects of ICT-supported scientific research processes as sampling and access. Regarding Web-based surveys, Cook *et al.* (2000) have pointed out that, rather than eliciting fake responses, such surveys may elicit lower response rates. Similarly, Ward *et al.* (2014) assert that online surveys have disadvantages with respect to validity and reliability, and they have limitations in sample selection.

The researchers participating in the study also made some suggestions and predictions about the use of digital technologies in scientific research. According to these predictions, the use of digital technologies in scientific research will create a new research network in time; this approach will rapidly spread in the science networks soon and provide rich data for educational studies. Especially in educational research, it is emphasized that Web-based data collection tools enable collaborative work and increase quality (Boulos *et al.*, 2006; McMillan and Schumacher, 2010). To Dutton (2013), the continuing advance and diffusion of digital research make it ever more important to strengthen the role of the social sciences. Finally, researchers suggest that data collection tools need to be plain and simple, the decision on whether to do the research electronic or paper-based must be grounded in the light of its purpose, the data collection process must be conducted as per scientific research methodology and the data collection tools must be informative. These suggestions support Best and Krueger's (2004) prediction that digital technologies will in time provide alternative question formats, different listing options, various audio-visually assisted data collection tools and designs. Similar to the findings of this study, by analyzing the electronic tools used in data collection in terms of "confidentiality and security issues, non-respondent follow up, progress indicators, response completeness and quality, response options, response rates, response speed, restricted access, sample selection, survey method resource savings, technical issues, and Web survey design features," Truell (2003, p. 32) has found that one of the most crucial features of internet-based data collection tools is that they must be prepared in an uncomplicated, easy-to-understand way.

5. Conclusion and suggestions

Despite the spreading use of advanced technologies such as big data, data visualization and data mining in scientific research, it has been found that the researchers participating in this study mostly use traditional data analysis programs like SPSS, NVivo and Lisrel, followed by academic databases. Additionally, social web applications, online questionnaire applications, games and simulations have also been found to be commonly used.

The opinions obtained by following the explanatory mixed-method research procedures were analyzed, and the themes elicited via content analysis were grouped into four main categories as "advantages, disadvantages, suggestions and predictions." All the identified categories and relationships are presented in Figure 8.

When the opinions about the advantages of using digital technologies in scientific research were analyzed, nine themes stood out. Of these themes, the most cited three themes were: easy data collection, reduction of the research cost and time and reaching a high number of participants. As for the disadvantages of use of digital technologies, the most-often cited ones were fake response and threat to external validity. These disadvantages related to online data collection mostly stem from the lack of an established culture of technology-based research. These opinions regarding the advantages and disadvantages of using digital technologies in educational research support the findings elicited from the quantitative data analysis. These results, where greater stress is placed on the advantages of using digital technologies, are parallel to the majority of the findings in the relevant literature.

The participants made some predictions and suggestions on the use of digital technologies in research. They have predicted that the use of digital technologies in scientific research will create a new research network, that this approach will rapidly spread in scientific communities and will soon provide a rich data resource for educational research. The suggestions of educational researchers on the use of digital technologies in scientific research are listed below:

(1) ICT-assisted data collection tools should be plain and intelligible so as not to bore or bother participants.

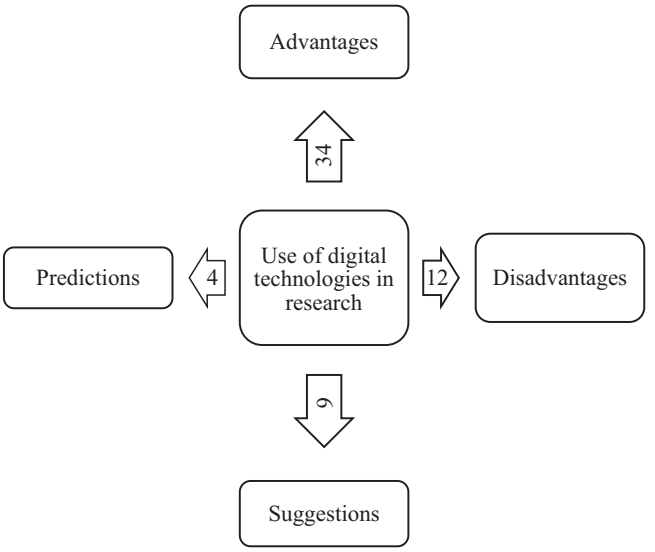

Figure 8.
Use of digital technologies in social science research

(2) Whether or not to use digital technologies should be decided according to the purpose of the planned research because every study is different and may require either electronic or paper-based data collection.

(3) One of the major problems of using digital technologies in educational research involves methodology, which means that the data collection process and analysis in ICT-assisted research should be conducted in line with the scientific research methodology.

(4) To prevent fake answers, to achieve sincerity in the face-to-face or paper-based data collection process, to ensure voluntary participation and to be able to collect valid and reliable data, ICT-assisted data collection tools should contain adequately informative content for the participants.

Fake answers, threat to external validity, qualitative research inadequacy, problems in researcher–participant communication and participants' perception of the e-researcher as disturbing or boring were identified as major disadvantages of using digital technologies in educational research. By conducting further research, the reasons for these drawbacks can be more extensively analyzed, and more rigorous evidence-informed solutions for overcoming them can be offered. Regarding online data collection processes in educational research, opinions from both the researcher and participants can be analyzed and compared. As a practical suggestion, researchers who will conduct research on the use of digital technology in research, especially online data collection in educational research, can benefit from this research and its findings.

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