Methodological Evaluation of the Use of ICTs in Mixed Method Research in Education

BİT'lerin Eğitimde Karma Yöntem Araştırmalarında Kullanımının Yöntemsel Açıdan Değerlendirilmesi

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Abstract: The purpose of this phenomenological research was to evaluate the use of Information and Communication Technologies (ICTs) in mixed method research (MMR) in education from a educational researchers' methodological perspective. Semi-structured interviews were conducted with 12 educational researchers. The data were analyzed by thematic content analysis. Nine themes were identified in the interviews with educational researchers. The most emphasized contribution of ICTs was found to be about data collection. Six of the themes explained the need for new data collection tools and positive evaluations of ICTs on triangulation and transformation of data by collecting massive, in-depth and original data for MMRs. Two themes were about the role of the researcher in MMRs. Educational researchers argued that the use of ICTs in MMRs can support collaborations among researchers and reduce researcher limitations. Finally, educational researchers underlined the critical importance of the discovery of new MMR models in digital age.

Keywords: Educational researcher, mixed method research (MMR), information and communication technologies (ICTs) in scientific research.

Öz: Bu fenomenolojik araştırmanın amacı, Bilgi ve İletişim Teknolojilerinin (BİT) eğitimde karma yöntem araştırmalarında kullanımının eğitim araştırmacıları tarafından yöntemsel açıdan değerlendirilmesidir. Eğitim alanından 12 araştırmacı ile yarı-yapılandırılmış görüşmeler yapılmıştır. Veriler tematik içerik analizi ile analiz edilmiştir. Eğitim alanından araştırmacılarla yapılan görüşmelerde dokuz tema belirlenmiştir. BİT'lerin en çok vurgulanan katkısının veri toplama ile ilgili olduğu bulgusuna ulaşılmıştır. Temalardan altısı, yeni veri toplama araçlarına olan ihtiyacı ve BİT'lerin karma araştırma yöntemleri için büyük, derinlemesine ve orijinal veriler toplayarak, verilerin sağlaması ve dönüştürülmesi üzerindeki olumlu değerlendirmeleri açıklamaktadır. İki tema araştırmacıların karma araştırma yöntemindeki rolü ile ilgilidir. Eğitim alanındaki araştırmacılar, BİT'lerin karma araştırma yöntemlerinde kullanılmasının araştırmacılar arasındaki işbirliğini destekleyebileceğini ve araştırmacının sınırlılıklarını azaltabileceğini savunmaktadır. Son olarak, eğitim alanındaki araştırmacılar, yeni karma araştırma yöntemi modellerinin keşfedilmesinin dijital çağdaki kritik öneminin altını çizmektedir.

Anahtar Kalimeler: Eğitim araştırmacısı, karma yöntem araştırması (KYA), bilimsel araştırmalarda bilgi ve iletişim teknolojileri (BİT)

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Introduction

All technologies, including communication and computer technologies, which enable the collection, processing, storage, and transmission of information through networks, are called "Information and Communication Technology (ICT)" (Juhaňák et al., 2019). Technology-based ICTs are developing with the advent of new technologies (Alt, 2018). As a result of these developments, it can be said that the usage areas and scope of ICTs have expanded. The advances in ICTs expanded the capacity and scope of scientific research methodology. Continuously enhanced by Web technologies, ICTs started a revolution for scientific research (Dutton, 2013) because they allow to do quicker, easier and more comprehensive research. ICTs can be used not only to obtain more data but also to access larger sample sizes. In particular, with the transition from Web 1.0 to Web 2.0, it has become easier for researchers to collect data. In addition, Web-Human interaction was enabled with the transition from Web 1.0 to Web 2.0 (Germanakos & Belk, 2016). In this way, it was possible to create the content presented on the Web by users and to share these contents with others. Therefore, more flexible and more user-friendly interfaces have been developed with Web 2.0 (Germanakos & Belk, 2016). It can be stated that the more common use of internet technologies such as Web 2.0 is an important step in obtaining and analyzing data more easily in scientific research processes. With the popularization of the Internet technologies, unlimited data pools have emerged that have been accumulating in gigantic databases for years. Increasing exponentially and paving the way for new opportunities, these data have extended the limits of research that can be conducted via ICTs. According to Hackett (2011), these new technologies have a transformative effect for scientific research (Hackett, 2011, p. 26). The most important feature of this gigantic and rich digital data is diversity (navigation nodes, the number of hits, timestamp, logs, likes, comments, answers, shares, etc.). These features, which emphasize both quantitative and qualitative characteristics, have brought methodological power to MMR.

Benefiting from electronic environments as a tool in scientific research has become an important and effective practice for scientists and researchers (Dutton, 2013; Topp & Pawloski, 2002). Online data collection conducted through e-mails and Web-based questionnaires has become an increasingly popular research method (Granello & Wheaton, 2004) so much so that new professional respondent groups have emerged who frequently participate in surveys and are mainly doing so for the incentives (Buchanan & Hvizdak, 2009; Matthijsse, de Leeuw, & Hox, 2015). Researchers from all around the world can access scientific research data, conduct collaborative studies in all fields, and share data and research results on the Internet. 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. Similarly, Kılınç and Fırat (2017) stated that online data collection is more positively met by the participants. Accordingly, participants in online environments can easily express their opinions. These new environments and opportunities for collecting qualitative and quantitative data have the potential to extend the boundaries of MMR.

Fielding (2012) discusses new technologies in data integration for MMR and underlines the innovative forms of data integration as the geo-referencing software and multistream visual data. As triangulation is about whether findings from different methods agree, ICTs can be used to support the validity of scientific findings. Furthermore, O'Halloran, Tan, Pham, Bateman and Moere (2016) explain a digital mixed method design which extends MMR into the realm of data mining and information visualization for big data analytics (p. 18). In this way, it is possible to

present the data obtained from the participants in a more understandable way within the scope of the scientific research. In addition, the use of ICTs in scientific research provides more detailed findings (Bond & Ramsey, 2010). According to Bond and Ramsey (2010), the effective use of ICTs in scientific researches makes the analysis and interpretation of the findings more efficient and increases the validity and reliability of the research. More recently, social media data analysis, big data analysis and learning analytics have come into prominence. Electronic tools and applications have become popular data collection tools, and the Internet has become a popular data collection environment with the alternative question formats, alternative listing options, and audio-visual support provided by ICTs allow various data collection tools and designs to be used (Best and Krueger, 2004). However, perhaps more importantly, with its previously entered innumerable data, the Internet is a newly-discovered data source for researchers. Besides, thanks to ICTs, it is possible to reach large heterogeneous group of participants and collect data efficiently (Padayachee, 2017).

There are numerous electronic environments and tools which can serve different scientific purposes for MMR such as online questionnaire platforms (Google Docs, Survey Monkey, Quatrics and JotForm), social Web analysis and data collection (Facebook, Twitter, Forums, Blogs, Wikis). The ICTs used in scientific research are not limited to the Internet. The number of scientific studies using advanced cloud computing, big data, Web analytics, programs and software is also rising.

In his review of the history of the MMR, Maxwell (2016) states that the process that began with Campbell and Fiske's (1959) triangulation work continued in the 1980s and in this period there has been a growing interest and preference by researchers in using multiple methods rather than individual qualitative or quantitative methods in scientific research. Regarding the evaluations of ICTs in mixed methods, this change in qualitative and quantitative methods can be said to have directly affected the mixed method, as well.

Hesse-Biber and Griffin (2013) examined a range of MMR that employ Internet technologies for data collection. They underline that ICTs have operational power that can change the "mode" of traditional research. Hesse-Biber and Griffin (2013) explain this power as follows:

"...As Internet-mediated communications continue to become a central aspect of how individuals interact with one another, mixed methods researchers will be drawn increasingly to Internet-mediated data collection designs… (p. 58)"

MMR studies tend to benefit from ICTs much more than qualitative-only or quantitative-only studies do. As an innovative methodological approach, mixed method designs adapted these technologies in research process more effectively. The use of a large number of technological tools such as NVIVO, SPSS, Leximancer, in both qualitative and quantitative mixed method analyses can be stated as a reason for this. In addition, new research programs that will emerge with the development of ICTs are seen as a situation that will be used in MMR studies in the future. Design-based research can be given as a good example of MMR design. Fielding, (2012) discussed the data integration with new research technologies to support the triangulation in mixed methods designs. Hesse-Biber and Griffin (2013) emphasize the need for further research on rapidly changing ICTs in MMR. As ICTs continue to become a central aspect of MMR, researchers will be drawn increasingly into the Internet-mediated data collection designs. Few studies have examined the potential of advanced ICTs such as big data, analytics, data mining and information visualization in the practice of mixed methods research (Hesse-Biber & Griffin, 2013; O'Halloran et al., 2016).

The literature review also reveals various studies about ICT-assisted research, which mostly focus on the opportunities provided by ICTs (Bhatti, 2013; Birnbaum, 2004; Wishart and Thomas, 2015) and how ICTs can be integrated into MMR (Fielding, 2012; Hesse-Biber & Griffin, 2013; O'Halloran et al. 2016). However, the literature review shows that despite the intensive use of ICT in MMR, educational researchers' opinions on the evaluations of ICT use for MMR have not been investigated adequately. The purpose of this research is to make a methodological evaluation of the use of ICTs on MMR in line with the opinions of educational researchers.

Method

Research Design

This study was designed as phenomenological research. Phenomenological research is a type of qualitative research that tries to make explicit the implicit structure and the meaning of human experience (Sanders, 1982). This study was designed with phenomenology, which is one of the qualitative research designs, as it aims to determine the experience of educational researchers regarding the use of ICTs in MMR phenomenon.

Study Group

Participants were selected by purposeful sampling. Criterion sampling strategy of purposeful sampling method applied. Purposeful sampling is widely used in qualitative research for the identification and selection of information-rich cases related to the phenomenon of interest (Palinkas et al., 2015). The main sampling criteria was experience in MMR in the field of education. Semi-structured interviews were conducted with 12 educational researchers including a professor doctor, an associate professor, and 10 PhD students who have experienced in MMR. In the direct quotes, pseudonyms like Zeynep, Ali and Nur were used to protect the participants' anonymity. Table 1 shows the characteristics of the participants.

Table 1.

Characteristics of the Participants

No	Pseudonym	Gender	Title	Institution
1	Zeynep	Female	Prof. Dr	Anadolu University
2	Ali	Male	Assoc. Prof. Dr.	Trakya University
3	Tuna	Male	PhD Student	Ege University
4	Arda	Male	PhD Student	Ege University
5	Meral	Female	PhD Student	Trakya University
6	Kerem	Male	PhD Student	Çanakkale 18 Mart University
7	Hasan	Male	PhD Student	Muş Alparslan University
8	Fatma	Female	PhD Student	Anadolu University
9	Nur	Female	PhD Student	Anadolu University
10	Leyla	Female	PhD Student	Anadolu University
11	Burak	Male	PhD Student	Anadolu University
12	Masal	Female	PhD Student	Anadolu University

Data Collection

Data were collected via semi-structured interviews. In order to collect qualitative data, an open-ended semi-structured interview form was prepared. The interview form was checked by two experts who teach qualitative research methods to doctorate students. The interview form was then revised by following the experts' suggestions. The main question of the semi-structured interviews was "How do you evaluate the use of ICTs in MMR in education?". The probes of the main question were "Evaluations on data collection process, evaluations on research process and evaluations on the structure of MMRs". Interviews with 12 participants took at least 3 minutes and at most 11 minutes. The average duration of the interviews was calculated as approximately 6 minutes.

Data Analysis

Thematic content analysis was used in qualitative data analysis, for which inductive analysis was applied. 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). Participants' evaluations about the use of ICTs on MMR were transcribed and then transferred to NVivo package program for data analysis. The raw data were encoded and themes were accessed from the codes in accordance with the thematic content analysis. After determining the themes of each researcher, the compatibility with other researchers was examined. After this stage, the reliability study was carried out and the consistency of the researchers in their coding was determined. In calculating consistency between coders, the level of compliance was determined as .92 by using Miles and Huberman's (1994) formula Reliability = Number of Agreements / (Total Number of Agreements + Disagreements)'. During the analysis process, the opinions of the participants were presented directly in their original form.

Findings

The opinions of educational researchers on the evaluations of ICTs on MMR were subjected to inductive content analysis. The raw text in the NVIVO program was coded and analyzed, yielding a total of 9 themes. These themes can be grouped under three categories as data, researcher, and model. These themes are given in Figure 1 below.
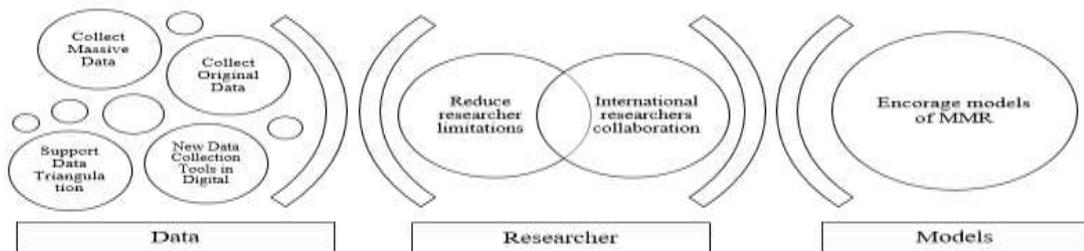

Figure 1. Evaluation of ICT usage on MMR according to the views of education researchers

Given in Figure 1, six of the themes are about structure of data and data collection process. Two participants underlined the need for "New Digital Data Collection Tools" for MMR. This theme emphasizes the need for new digital data collection tools as our behaviors and lives are also moved to digital. The direct quote is given below.

> *"...Actions, movements and behaviors of human are carried to the digital. We now live part of our everyday life in the digital environment. But we are still trying to use techniques such as traditional questionnaire, scale, observation and interview to do research about experiences and indicators. We are conducting research by transferring these traditional data collection tools to digital media. But to me, we now need original data collection tools, techniques and technologies that can be used in the digital environment. For example, semantic web technologies, organic search technologies, Web agents, data collection micro-programs can develop here as new data collection tools..."* Fatma

According to these educational researchers, our experiences and interactions have become digital. In order to collect multimodal data in these new environments we need to develop new types of data collection tools with the support of logs, algorithms, semantic Web technologies, search engines, organic connections, Web agents and micro research programs.

Theme of 'Support Data Triangulation' was mentioned by two educational researchers. To the researchers, ICTs provide different opportunities to support data triangulation in MMR. At this point, the triangulation of data obtained from various sources can be realized by using from eye tracking to sound recordings. The direct quote from a participant is as follows:

> *"...We are not just observing and interviewing ... at the same time we use video records, voice records in our research. We have investigations about eye-tracking with participants ... we want the user to tell where to look with voice record, we make video recordings in studios ... so these digital tools enable us to do our multi-dimensional research in the real sense...."* Meral

One of the interesting themes revealed in the present study was 'Transformation of Data Types'. Transformation of data types is possible with ICTs tools. Verbal data can be expressed as numeric data and numerical data can also be verbalized. A participant assumed that by use of ICTs, it is possible to transform qualitative data into quantitative and vice versa:

> *"...Data such as like, follow, hashtag, emoji reached in social media can be converted into numerical data. Similarly, quantitative data can be transformed into qualitative data by further visualizing data, such as statistics on maps...."* Masal

The researchers also mentioned the themes "Collect Massive Data", "Collect Original Data" and "In-depth Data Collection". To them, it is easier to collect massive data by using ICTs. It is possible to collect data from many participants in a short time with advanced massive ICTs based data collection tools. Other themes of "Collect Original Data" and "In-depth Data Collection" are very interesting. Two participants assumed that by the use of advanced ICTs like sensors of mobile technologies, eye-tracking, TV integrated video camera, and digital logs, it is possible to collect real (authentic, natural) data from the real lives of participants. In addition, collecting in-depth and detailed data from same participants is possible with these advanced ICT-based tools. The direct quote is given below.

> *"...As a different dimension, virtual research has been moved to the natural environment. In recent studies, we are now able to carry these technologies to people's homes, and now, like simple eye-tracking devices, can now receive data based on the process. And in its natural environment, the research process has moved completely into its natural surroundings, thanks to digital technologies...."* Nur

"Reducing Researcher Limitations" and "International Researchers Collaboration" themes were about researchers. According to the participants, the use of ICTs tools in the MMR process facilitates cooperation, communication, interaction and collaboration. One participant emphasized the changing role of researchers in terms of research team internationalization and collaboration. The participant emphasized the enhanced collaboration of scientific research teams by the help of ICTs:

> *"... No longer do people conduct research separately. Researchers can work as if they were in the same place. Even if I may not know the person I work with, I know his/her characteristics, features, areas of expertise and in what matters I can get support...."* Ali

"Reducing researcher limitations" is another interesting theme revealed in this research. 3 participants emphasized the positive evaluations of ICTs on reducing researcher bias. Accordingly, the research process of the researcher becomes easier and more efficient. According to this participant, it is possible to collect, store, and process rich data through advanced ICTs:

> *"...We had to look through the glasses of researchers in traditional research. We could only see from the eye of the researcher. But now, not just the researcher's eyes, but the digital rich data provided changes the nature of the research…"* Leyla

The final and probably the most comprehensive theme was "Encourage new models of MMR". It can be said that ICT tools are great in the emergence of new models such as design-based research. Two participants underlined the importance of the discovery of new MMR models in digital age.

> *"...like design-based research, a method based on the interaction of practitioners and researchers and a mixed methodology are used…"* Tuna

> *"...The use of digital tools is very important in the creation of collaborative, interactive designs for research, and we should discover new models and designs like design-based research…"* Hasan

The views and suggestions of educational researchers on the requirement of new research models of MMR are based on the emergence of new interactions in new digital environments. The main argument is that traditional research tools, methods, techniques are not sufficient and appropriate for these new social and interactive environments.

Discussion and Conclusions

Findings show that the integration of digital technologies with MMR can be evaluated very positively. Six themes emerging from the interviews related to data and data collection. These themes support the recent research. "Support Data Triangulation" theme supports the "data integration with new research technologies to support the triangulation in mixed methods designs" assumption of Fielding, (2012). Integration of geo-referencing technologies and stream data examples given by Fielding (2012) were also mentioned by the educational researchers who participated in this study. Hesse-Biber and Griffin, (2013) determined geographic interactive systems, new mobile technologies, sensors for social research, other ongoing ''real-time'' streaming data as some new technologies for MMR. The "Transformation of data forms" theme

supports the assumption of O'Halloran et al. (2016) on the facilitating role of ICTs in transforming qualitative data into quantitative data. This finding also supports the "ICT-supported integration of data through qualitative and quantitative methods" assumption by Fielding (2012). Similarly, the "Collecting massive data" and "In-depth data collection" themes also support the findings of Fielding (2012), Hesse-Biber and Griffin (2013), and O'Halloran et al (2016). However, the theme of "Collecting original data" is interesting and open to discussion. The originality in this theme underlines the realistic and context-original aspect of data.

Two of the themes revealed by the interviews were about the changing role of researchers with ICTs in MMRs. "Reducing researcher limitations" theme emphasizes that streaming digital massive data abilities of new technologies supports the reliability of collected data. In other words, ICT support reduces the risk of errors. This theme supports the "Use of ICTs in scientific research reduces the risk of bias" finding of Keusch (2013). In addition, Bond and Ramsey (2010) state that using ICTs during the research process allows bias-free and objective data collection and analysis processes, which leads to increased validity and reliability. The "International researcher collaboration" theme refers to the collaboration of researchers through ICTs, which strengthens the argument made by Borgman (2006), and Pinto, Wall and Spector (2014) in favor of the "facilitator role of ICTs for researcher collaboration". In addition, Kılınç and Fırat (2017) stated that collecting data in ICT-based online environments is welcomed by the participants and that the participants express their own expressions more comfortably. Accordingly, it is stated that these environments are asynchronous environments and therefore do not require instant answers has a positive outcome on participants' self-expression in online environments.

"New research models of MMR" theme was based on the views of educational researchers as regards the emergence of new interactions in digital space. The transformation of data in digital environments occurs bidirectionally: from qualitative to quantitative by big data via Web analytics, social network analysis, and learning analytics; and from quantitative to qualitative via data visualization technologies. Multimodal research framework of O'Halloran et al. (2016) can be shown as an example of the "New research models of MMR". This framework provides a social-semiotic approach to the MMR. Semiotic elements are mostly explained with multimedia components such as words, images, sounds or combination of these. This type of semiotics can be extended with social Web components such as likes/dislikes, follow, and all kind of emoji. Consequently, this approach can thus be utilized to explain the combination and transformation of data in digital environments.

About the evaluations of the ICTs on MMRs, nine themes were identified in the interviews with educational researchers. The most emphasized contribution of ICTs was found to be about data collection. Six of the themes explained the need for new data collection tools and positive outcomes of ICTs on triangulation and transformation of data by collecting massive, in-depth and original data for MMRs. Two themes were about the role of the researcher in MMRs. Educational researchers argued that the use of ICTs in MMRs can support collaborations among researchers and reduce researcher limitations (Dutton, 2013; Hackett, 2011; Kılınç & Fırat, 2017; Topp & Pawloski, 2002). The final, and the most important theme was on discovery of new research models of MMR. Educational researchers discussed the requirement of new mixed method designs and models in digital age like design-based research (Fielding; 2012; Hesse-Biber and Griffin, 2013; O'Halloran et al., 2016).

Another important result identified in this study was the inadequate know-how of researchers about the use of advanced ICTs in scientific research. O'Halloran et al. (2016) and Hesse-Biber and Griffin, (2013) also underlined the need for methodological knowledge and experience to be able to use technologies such as big data, data mining, social network analyzes, analytics or data visualization techniques for the analysis of large data sets. In other words, integrating the methodology section of scientific researches with ICTs will provide a more efficient interpretation of the findings from the study (Verma, 2017). In this way, the readability and comprehensibility of the findings obtained in the scientific researches will be easier (Misra et al., 2017).

For MMR, further research can investigate the changing role of researchers in advanced ICT supported studies. In addition, the originality, reliability, validity, and accuracy of data can be compared in the traditional versus ICT-supported MMR designs. More practicaly, a list of useful ICTs may also be proposed to be used by researchers who will conduct a mixed-method research. These proposed ICTs are;

- Scientific research portals such as Research Gate which offers amenities such as ask questions, start a discussion, get feedback from researchers.

- Learning analytics from LMS, CMS and other learning portals which has the potential to provide in-depth information about learners

- Discussion sections of Web portals, social media, news sites can provide unique qualitative data from people which is clear from research bias.

- Web analytics of any kind of Web site or mobile page which have potential to provide can present time stamped, instant and realistic data.

- Collecting both qualitative and quantitative data in online environments that are strengthening with ICT is important for providing flexibility to the participants and expressing their ideas more easily.

- The power of ICTs should be used to reach broader and heterogeneous groups.

Limitations

This research is;

- With the opinions of 12 educational researchers who contributed to the research,

- With the use of ICTs in mixed method research in education,

- With the phenomenology method,

limited.

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