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Application of modern digital tools in the organisation of scientific and pedagogical research

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Abstract. The article addresses the problem of applying modern digital tools in the organisation of scientific and pedagogical research. The purpose of the study is to substantiate the possibilities of using contemporary digital instruments at the main stages of the research process and to systematise their functional potential for theoretical analysis, empirical data collection, processing, interpretation and dissemination of results. It is established that the evolution of research instrumentation proceeds from the use of information and communication technologies to computer-based tools and further to integrated digital environments that transform the organisation of research activity. It is demonstrated that each stage of scientific and pedagogical research necessitates specific digital support tailored to its methodological tasks: conceptualisation and work with sources at the theoretical stage, automated data collection and processing at the empirical stage, and analytical generalisation and dissemination of results at the final stage. The specific features of scientific and pedagogical research, related to the complexity, openness, and dynamism of its objects, are identified, which necessitate methodological validity, reliability of measurements, and careful interpretation of results. It is demonstrated that digital platforms, online research tools, statistical software, cloud services and artificial intelligence systems enhance the efficiency of research procedures while simultaneously generating new methodological challenges. It is concluded that the effectiveness of digital tools in scientific and pedagogical research depends on their integration into a coherent methodological framework, which ensures both technological efficiency and the scientific validity of research outcomes.

Keywords: scientific and pedagogical research, research methodology, digital technologies, digital tools, research instrumentation

1. Introduction

In its fundamental characteristics, the contemporary scientific and pedagogical experiment is undergoing significant transformations compared with the practices of earlier periods. These transformations are manifested in changes in organisational forms, means of implementation, and the structural and procedural logic of the research process. They are driven primarily by the rapid development of digital technologies, which not only expand the researcher's instrumental capabilities but also necessitate a reevaluation of traditional approaches to planning, conducting, and analysing experimental data.

Under present conditions, the methods, techniques and technologies used to organise experiments increasingly rely on digital tools or presuppose their integration into the research process. The use of networked resources, particularly the Internet, has shaped a specific format of research conducted in digital environments, which requires special attention to the procedures for selecting instruments, the methods for recording results, and the mechanisms for ensuring data quality. For this reason, a

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balanced and scientifically substantiated selection of digital tools acquires the status of a system-forming factor in research organisation, determining not only operational and procedural efficiency but also the level of validity, reliability and reproducibility of the results obtained.

The systemic application of digital technologies within scientific and pedagogical experimentation provides grounds for identifying the emergence of an instrumentally mediated model of psychological and pedagogical research. Within this model, digital tools perform not an auxiliary but a conceptually significant function, providing instrumental support for all stages of the research process – from the conceptual design of the experiment and the organisation of empirical data collection to their statistical analysis, interpretation, and scholarly presentation of results.

2. Literature review

In contemporary scholarly discourse, the concept, essence, structure and methodological foundations of scientific research are characterised by stability and solid theoretical justification. In the works of national and international scholars, a shared understanding of research activity has emerged as a specific form of cognition based on the principles of systematicity, purposefulness, evidence-based reasoning, and methodological verifiability of results [14, 15]. The fundamental characteristics of scientific research, including its internal logic, stages, and the requirements for the validity and reliability of the data obtained, generally do not give rise to conceptual disagreement and constitute a stable theoretical foundation for modern research methodology [8].

Scientific research is regarded as a specific form of cognitive activity aimed at the systematic and purposeful study of objects and processes of reality through the use of specialised methods and instruments of scientific inquiry. Its defining feature is an orientation towards obtaining objectively significant, theoretically grounded and methodologically verified knowledge about the object under investigation. In this context, scientific research is understood not as a set of isolated procedures, but as an integrated process that combines problem formulation, hypothesis development, method selection, empirical verification, and interpretation of results within the logic of scientific argumentation.

In the works of national and international scholars, *scientific and pedagogical research* is interpreted as a specific type of scientific inquiry whose subject area is associated with the study of the regularities of teaching and learning processes, as well as the factors and mechanisms of personal development in the educational environment. Chaichenko et al. [4] emphasises its complex nature, which is manifested in the combination of theoretical and methodological analysis with empirical study of pedagogical reality, as well as in the need to take into account the sociocultural, psychological, and institutional determinants of educational activity. Unlike research in the natural or technical sciences, pedagogical research deals with open, dynamic, and multifaceted objects, which results in heightened requirements for the justification of methods, the correctness of interpreting results, and the scientific soundness of generalisations.

The functional purpose of scientific and pedagogical research is not limited to the description and explanation of educational phenomena. It is also oriented towards forecasting trends in the development of educational processes, providing a scientific basis for pedagogical innovations and ensuring the methodological support of practice. Such an orientation facilitates the integration of theoretical reflection with applied aims, enabling the transformation of research findings into pedagogical technologies, methods, and organisational models of educational activity.

As demonstrated in our previous studies [8], the specificity of the methodological instrumentation of scientific and pedagogical research is primarily determined by the characteristics of its object, which is the human being in the processes of education, learning and development. Pedagogical research focuses on the individual as a bearer of personal experiences, values, motivations, and social meanings. Consequently, the methods of scientific and pedagogical inquiry cannot be reduced exclusively to rational and instrumental procedures of measurement and fact registration. They presuppose a combination of quantitative and qualitative approaches, consideration of subjective interpretations, contextual conditions and ethical constraints, which ensures an adequate representation of complex and multidimensional pedagogical reality.

In contemporary research, a consistent renewal of the instrumentation of scientific and pedagogical activity can be observed, based on the implementation of technological innovations and the development of ideas aimed at improving research methodology. In the works of Kostenko and Pasov [6], Spirin et al. [12], emphasis is placed on the need to expand traditional means of organising the research process through the use of new technological resources capable of increasing the accuracy of measurements, the efficiency of data processing and the analytical substantiation of results.

First and foremost, this renewal is associated with the analysis of the possibilities of information and communication technologies, which are regarded as a means of optimising work with the source base, collecting empirical data and organising research interaction [1, 7, 11]. Further development of the instrumental component of research in the literature is linked to the use of computer-based tools, specifically software for testing, statistical processing, visualising results, and modelling educational processes [5]. At this stage, the emphasis shifts to automating procedures and enhancing the technological efficiency of research operations [14].

In recent publications, a shift can be observed towards understanding digital technologies as a comprehensive environment for organising scientific and pedagogical research [9]. Barna and Kuzminska [2], Beskorsa and Havrilova [3], Pryhodii [10] consider digital tools not merely as technical means but as a component of research methodology that transforms how information is searched for, data are processed, results are presented, and communication is conducted within the scholarly community. Such an approach indicates a transition from the fragmented use of individual technologies to the formation of an integrated digital infrastructure of research activity [13].

Thus, the analysis of scholarly sources demonstrates the existence of well-established theoretical and methodological approaches to understanding the essence of scientific and pedagogical research, alongside an active search for ways to update its instrumentation in the context of technological change. Despite the considerable number of studies devoted to the use of information and communication, computer-based, and digital tools in research activities, the scholarly discourse continues to reveal a need for a systematic interpretation of their potential, specifically from the perspective of research organisations. This necessitates the generalisation of existing approaches and the identification of possibilities for applying modern digital tools within the structure of scientific and pedagogical research.

3. Research objective

The *purpose of this article* is to provide a scientific substantiation of the possibilities of applying modern digital tools in the organisation of scientific and pedagogical research, taking into account the stage-based logic of the research process. Within the stated objective, attention is focused on analysing the functional role of digital instruments

at the theoretical and empirical stages, as well as the stages of data processing and generalisation of results, and on identifying the methodological principles for their appropriate and methodologically sound use in pedagogical research.

4. Results

In scientific methodology, a stage-based logic of organising research is well established, ensuring its consistency, internal coherence and methodological rigour. In the present study, scientific and pedagogical research is structured into three main stages: the theoretical stage, the empirical stage, and the analytical stage, which integrates data processing and the generalisation of results. Such structuring reflects the logic of scientific inquiry and provides methodological grounds for analysing research instrumentation in accordance with the tasks of each stage. In what follows, the possibilities of modern digital technologies in optimising scientific and pedagogical research at each of these stages are examined.

4.1. Digital tools for the theoretical stage of scientific and pedagogical research

We begin our review with the theoretical stage of scientific and pedagogical research, which aims to conceptualise the problem field and establish the scientific foundation for subsequent empirical procedures. At this stage, the direction and topic of the research are determined, its object and subject are specified, the research purpose is formulated, and the categorical framework is outlined. Of fundamental importance is the clear definition of the object and subject of the study, as well as the formulation of the research aim, since without this, the subsequent work loses methodological coherence and acquires the character of an unsystematic process of trial and error.

A central place at the theoretical stage is occupied by systematic work with primary sources, which involves the purposeful search, selection, analysis and synthesis of scholarly publications, regulatory documents and the results of previous studies. As a result of the analytical processing of theoretical sources, scientific knowledge is accumulated, the initial positions of the study are formed, the logic of further work is refined, and the prerequisites for producing an original scientific outcome are created. This process is illustrated in figure 1.

The *source base* of scientific and pedagogical research comprises a set of scholarly, reference, and regulatory materials that facilitate the theoretical comprehension of the problem and the formulation of the researcher's position. Traditionally, it includes monographs, articles in peer-reviewed journals, conference materials, dissertation studies and abstracts, reference and encyclopaedic literature, as well as legal and regulatory documents in the field of education. The representativeness of the source base is determined not by the number of texts examined, but by their scholarly significance, conceptual relevance to the subject of research, and their capacity to reflect the evolution of scientific approaches to the problem. It is at this level that the theoretical foundation of the study is formed, the conceptual and categorical framework is refined, and the methodological guidelines for further work are outlined.

At the same time, under contemporary conditions, the formation of the source base increasingly takes place within the digital scholarly environment, which substantially transforms the organisation of the researcher's search and analytical activity. Alongside traditional library collections, national and institutional repositories, electronic libraries, academic search platforms, scientometric databases and professional scholarly communities are employed. This expands access to scientific resources, ensures the efficiency of retrieval, and creates conditions for the systematic analysis of the problem field.

To specify contemporary approaches to forming the source base at the theoretical stage of research, it is appropriate to identify the main environments and technologies

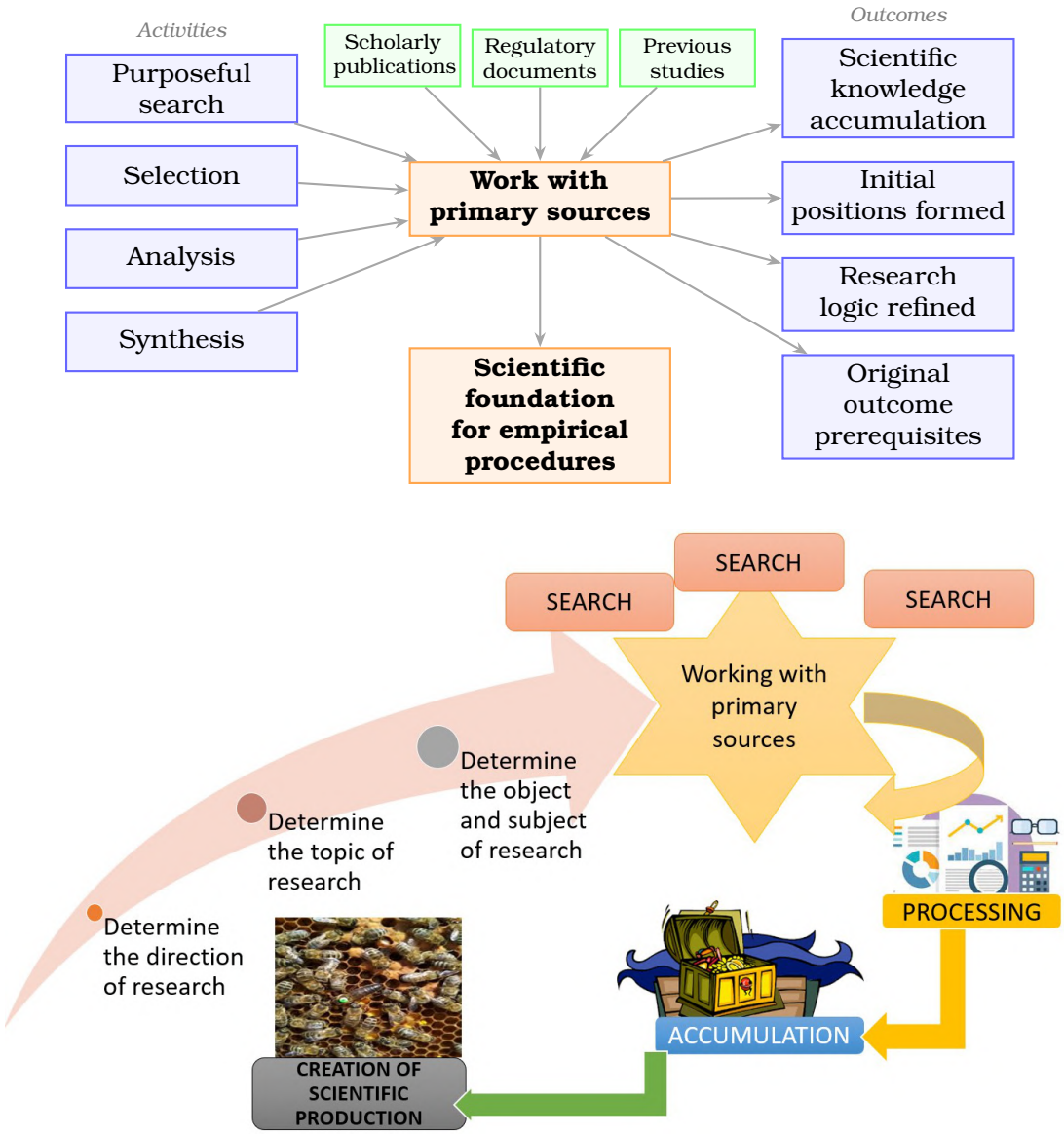

Figure 1: Structure and logic of the theoretical stage of scientific and pedagogical research.

for searching scholarly information and determine their functional role in organising the research process. Particular attention is paid to both traditional library and national resources, as well as to digital platforms, scientometric databases, and artificial intelligence-based tools that provide semantic search, analytical processing, and preliminary descriptions of scholarly sources (table 1).

The presented systematisation demonstrates that contemporary search technologies transform the logic of working with scholarly sources: from the linear browsing of catalogues to a multidimensional analysis of the academic space, within which the selection of literature is combined with the assessment of its relevance, scholarly significance, and position in the overall research context.

Source retrieval at the theoretical stage of educational research is based on the sequential organisation of cognitive actions: from preliminary familiarisation with the thematic field and the establishment of selection criteria to the formulation of search queries, the identification of sources within relevant information environments, their methodologically grounded selection, and structured storage for subsequent analysis. Such a logic ensures the manageability of the search process, its methodological

rigour, and its purposefulness. Of particular importance at this stage is working with terminology, including the use of synonyms, conceptual variants, and database thesauri, which enables the avoidance of randomness in searching and ensures the representativeness of the source base (figure 2).

Table 1: Contemporary technologies and environments for searching scholarly sources at the theoretical stage of research.

Model / search environment	**Specific resources and tools**	**Functions in building the source base**	**Methodological significance**
Traditional and electronic libraries	University libraries; subject-specific research libraries; V. I. Vernadskyi National Library of Ukraine; Library of the National Academy of Educational Sciences of Ukraine	Access to monographs, dissertations, peer-reviewed journals, archival collections	Ensure the foundational character of the source base and continuity of the scholarly tradition
National digital repositories	National Repository of Academic Texts (NRAT)	Access to full texts of dissertations, articles and research reports by Ukrainian authors	Represent the national scholarly discourse; ensure academic integrity and openness
General search engines	Google	Exploratory thematic search; identification of publications, websites of research institutions and projects	Auxiliary tool for preliminary navigation in the information space
Academic search platforms	Google Scholar, Semantic Scholar, BASE, Academia, Figshare	Contextual search for scholarly publications; identification of related works; citation analysis	Ensure relevance and systematic selection of sources
Bibliometric databases	Scopus, Web of Science, ResearchGate, WorldCat	Search by keywords, authors, journals and citation indices	Enable assessment of the scholarly significance of sources and the positioning of the research problem within the international research field
Institutional repositories	Repositories of higher education institutions and research organisations	Retrieval of local studies, qualification papers and staff publications	Extend the empirical and theoretical base through applied and context-specific materials
Professional scholarly communities	Professional networks, associations, thematic research platforms	Exchange of findings; access to preprints; discussion of new approaches	Facilitate topicality of the research agenda and integration into scholarly communication

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Model / search environment	**Specific resources and tools**	**Functions in building the source base**	**Methodological significance**
Reference management software	Zotero, Mendeley, EndNote	Organisation of sources; thematic grouping; generation of bibliographic records	Ensure systematicity, reproducibility and accuracy of referencing
Semantic platforms with AI components	Elicit, Connected Papers, Research Rabbit	Content-based search; construction of networks of related studies; identification of trends	Support conceptual selection of sources and analytical review of the problem
AI tools for source analysis	Scite.ai, Scholarcy, Explainpaper	Automated summarisation; analysis of citation contexts; explanation of complex passages	Optimise analytical work; require scholarly verification of outputs
AI-supported search engines and "smart query" systems	Perplexity AI, Bing AI, You.com (YouSearch), ChatGPT	Semantic search via natural-language queries; selection of relevant sources; preliminary bibliographic description	Shift search from keyword matching to conceptual analysis; require methodological oversight by the researcher

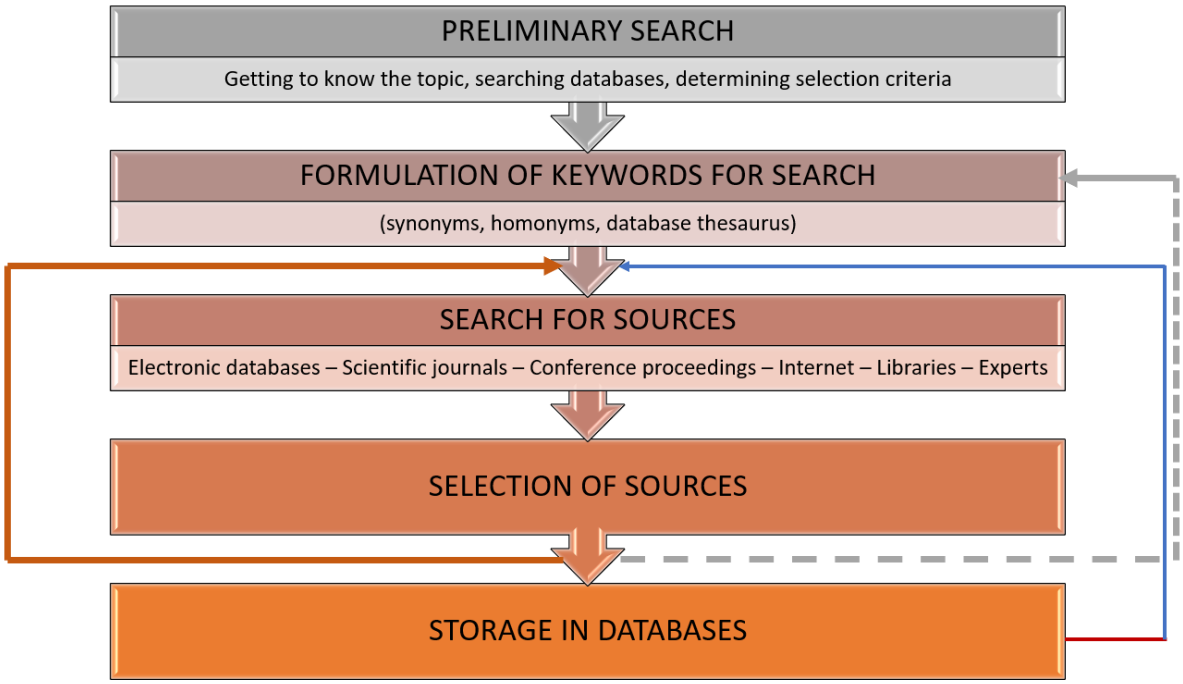

Figure 2: Scientific research procedure.

The possibilities available to the researcher are substantially expanded by contemporary artificial intelligence tools that support query formulation, source selection, and the initial processing of scholarly materials. A distinctive feature of searching with such tools is the capacity to formulate queries in the form of conceptually loaded research questions rather than merely as sets of keywords. Thus, instead of a formal query such as "digital tools pedagogical research", the researcher may employ extended

formulations, for example: “Which contemporary digital tools are used to organise the theoretical stage of educational research?” or “Which methodological approaches to building a source base have predominated in pedagogical research in recent years?”. Under these conditions, artificial intelligence tools perform semantic source selection, initial content synthesis, and the generation of preliminary bibliographic descriptions, which significantly optimise the analytical component of the theoretical stage.

At the same time, the use of artificial intelligence does not replace the researcher’s scholarly judgement. The final selection of sources, verification of their reliability, relevance and academic validity, as well as the interpretation of the results obtained, remain the methodological responsibility of the author.

An important component of the theoretical stage is the accumulation of search results in the form of a personally constructed research database. An effective technology for organising such a body of information is the research *process portfolio*, created as a single structured environment with a hierarchy of folders and files. Within this portfolio, downloaded scholarly articles, conference materials, dissertation studies, catalogues, analytical excerpts, and compiled reference lists are systematised, reflecting the logic of working with the source base. This form of organisation ensures not only the preservation of information but also the possibility of its thematic grouping, comparative analysis, and further interpretation.

Contemporary digital infrastructure significantly expands the possibilities for data accumulation through the use of *personalised cloud-based environments*. In particular, the researcher may create personal electronic workspaces in libraries and scholarly platforms, store search results in a Google Scholar profile, use reference management tools, and apply browser bookmarks to record relevant resources. Taken together, these means form a multi-level system of storage and access to sources, which supports the integrity of the portfolio and ensures rapid retrieval of any element of the source base.

For comprehensive work with primary sources at the theoretical stage of research, a set of software tools is required that provides not only the processing of textual, tabular, graphical and PDF materials, but also the recording, navigation and structured organisation of information. It is precisely these functions that enable the transformation of a collection of individual documents into an ordered research database, integrated into the process portfolio, with source documentation, rapid access, thematic grouping, and tracking of the logic of material processing. Table 2 presents the software required for analytical work with primary sources.

Structured notes constitute an effective tool for the analytical work with primary sources, as they ensure not only the recording of information but also the organisation of knowledge into an internally coherent system. For this purpose, both specialised applications (Obsidian, Notion, OneNote, Evernote) and the possibilities of structural text representation in general-purpose editors (Microsoft Word in Outline View, Google Docs with a hierarchy of headings, LibreOffice Writer) may be used. Unlike linear records, structured notes are built on thematic hierarchies, tagging, and cross-referencing between concepts and sources; each entry may contain bibliographic details, key ideas, and analytical commentary. Such an organisation facilitates comparative analysis and synthesis of material, transforming disparate fragments of information into an ordered body of knowledge.

Meanwhile, a necessary condition of methodological orderliness is the *systematic recording of completed work*. It is advisable to organise the working environment in the form of structured folders that reflect the status of material processing, for example: “new materials”, “in progress”, and “processed”. This organisation prevents duplication, facilitates navigation within the source base, and enables the tracing of the dynamics of the transition from searching to analytical synthesis. In combination

Table 2
Software for researchers' work with primary sources.

Functional purpose	Examples of software tools	Core capabilities
Processing textual materials	Microsoft Word, Google Docs, LibreOffice Writer	Editing, commenting, highlighting passages, excerpts, reference formatting
Working with tabular data	Microsoft Excel, Google Sheets, LibreOffice Calc	Data systematisation, sorting, filtering, analytical tables
Working with PDF documents	Adobe Acrobat Reader, Foxit Reader, PDF-XChange Editor	Text search, annotations, comments, export of excerpts
Processing graphical materials	Adobe Photoshop, GIMP, Canva	Editing diagrams, illustrations and scans; image preparation
Text recognition (OCR)	ABBYY FineReader, Tesseract OCR, Adobe Scan	Converting scans and images into editable text
Translation of scholarly texts	DeepL, Google Translate, Microsoft Translator	Preliminary translation, comparison of terminology
Information capture and note-taking	OneNote, Notion, Obsidian, Evernote	Excerpts, analytical notes, thematic grouping
Source management, navigation and structuring	Zotero, Mendeley, EndNote; browser bookmarks, Pocket, Raindrop.io	Source tracking, tagging, rapid navigation between materials, thematic browsing
File and portfolio management	OS file managers, Google Drive, OneDrive, Dropbox	Folder hierarchy, storage, versioning, access across devices
Note-taking (including structured notes)	OneNote, Notion, Obsidian, Evernote, All My Books, MyHomeLib	Recording excerpts and analytical comments; creating structured notes with tags, cross-links between concepts, thematic sections and hierarchical organisation of entries

with structured notes, it creates a manageable information environment for consistent and reproducible research work.

The final aspect of the theoretical stage consists of the systematic transformation of accumulated information into scholarly outputs. The collected sources, organised within the research database and portfolio, are gradually integrated through structured notes into coherent texts of individual subsections, which serve as the basis for preparing articles, conference abstracts, and methodological materials on the main research topic. It is of fundamental importance that such work be carried out regularly, through continual return to the notes, refinement of formulations, and logical alignment of arguments (figure 3).

In parallel, during the process of working with the source base, outcomes are generated that extend beyond the central focus of the study yet possess independent scholarly and methodological value. Such ancillary academic output includes methodological developments, analytical materials, and publications in adjacent or related thematic areas that do not constitute the direct core of the research but reflect a broader context of problem conceptualisation and the researcher's professional development. In this way, the theoretical stage ensures not only the preparation of crucial results but also the formation of an accompanying body of scholarly and methodological work.

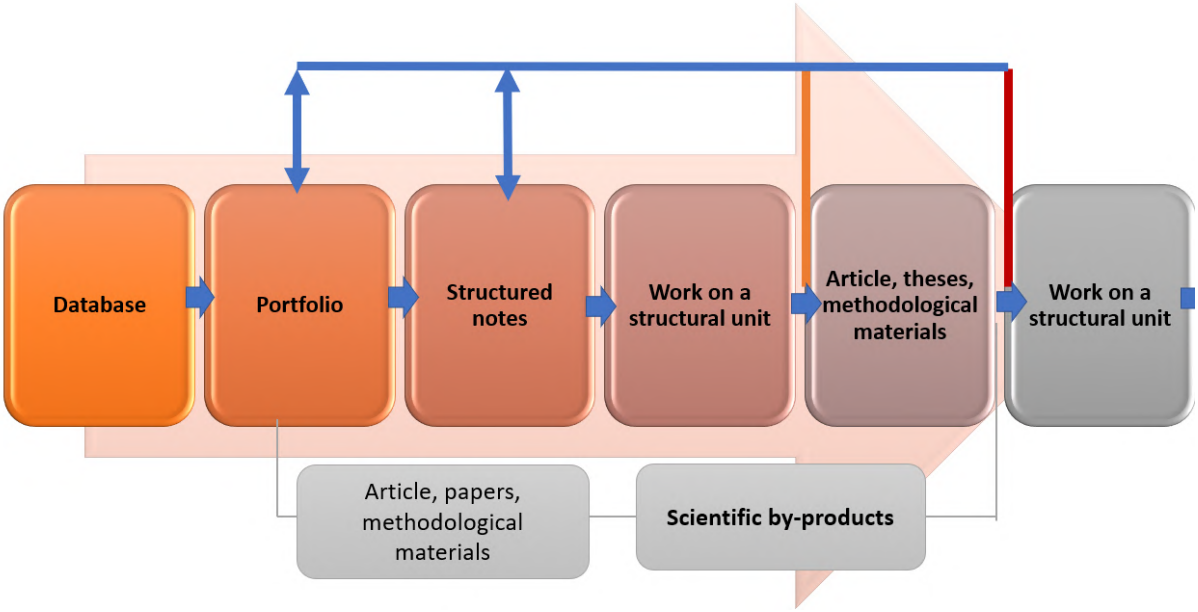

Figure 3: The logic of working on the problem at the theoretical stage of scientific pedagogical research.

4.2. Digital technologies of the empirical stage of research

It should be emphasised that the transition to the empirical stage of research is possible only under the condition of sufficient theoretical determination of the object of study. The researcher must clearly delineate the essence and content of the phenomenon under investigation, including its key features, structural characteristics, functional manifestations, and relationships with related categories. Additionally, the researcher should formulate a basic scientific hypothesis that reflects the logic of the subsequent inquiry. In the absence of such conceptual clarity, empirical procedures lose methodological controllability and fail to ensure the validity of the results obtained. Accordingly, if, at the point of transition to practical verification, a stable understanding of the research object has not yet been formed, or conceptual contradictions remain, it is advisable to continue working with primary sources, to deepen the analytical elaboration of theoretical propositions, and to refine the research orientations.

The empirical stage of research presupposes a methodologically *grounded selection of participants* and the appropriate organisation of measurement procedures. Under contemporary conditions, information and digital technologies enable the conduct of experimental and diagnostic procedures at virtually all stages of research, including remote and online studies. Nevertheless, their application requires methodological rigour in relation to sample construction, the assurance of measurement validity, and the control of extraneous variables.

The recruitment of participants for online research may be carried out through various information channels:

- the placement of announcements on general information and specialised platforms,
- publications within professional communities,
- thematic networks, and scholarly resources,
- targeted communication with potential respondents within educational and research communities.

Such an approach enables the formation of both large-scale and specialised samples, oriented towards specific socio-demographic or professional groups.

The collection of empirical data in a digital environment is carried out through electronic testing tools, online questionnaires, interactive forms, and specialised platforms for conducting remote experiments. The use of computer-based and web-oriented technologies enables the automation of procedures for recording results, data storage, and initial processing, as well as the conduct of monitoring measurements and the expansion of research scale without significant resource expenditure.

A major advantage of online research lies in the possibility of rapidly involving a large number of participants, which creates the conditions for enhancing the reliability of results, provided that the sample is constructed in a methodologically sound manner. The digital format also contributes to savings in time, financial and material resources, broadens access to groups that are heterogeneous in socio-demographic characteristics, increases the external validity of findings, and reduces the direct influence of the researcher on respondents' behaviour. Voluntary participation, the possibility of withdrawal at any stage, and anonymity frequently promote greater openness and sincerity of responses.

Nevertheless, the application of online formats entails several methodological constraints. These include a reduced level of experimental control over measurement conditions, limited possibilities for verifying the actual sample composition, the emergence of additional extraneous variables, and the dependence of results on the technical reliability of software and network infrastructures. Typical risks include repeated participation by the same respondent, discussion of tasks with third parties, the use of external prompts during task completion, and the formation of participants' assumptions about the "true" purpose of the study, which may influence their responses.

In view of this, a methodologically grounded approach to *sample* formation becomes of fundamental importance. The number of participants should be determined not only by the availability of respondents but also by the requirements of reliability and generalisability of results, the complexity of the variables under investigation, and the selected methods of statistical analysis. An increase in sample size may partially compensate for limitations of control in an online environment; however, it does not substitute for the qualitative selection of respondents and the clear definition of inclusion criteria.

For the purpose of enhancing the validity and reliability of findings, it is advisable to apply such methods, namely:

- the strengthening control, including the complication of participant registration procedures,
- the use of unique access identifiers,
- the formation of stable samples within online laboratories or educational platforms,
- the combination of remote and face-to-face measurement procedures.

Within this logic, digital tools are regarded not as a universal solution but as a component of a methodologically well-designed research framework.

Following the determination of the sample and measurement conditions, the empirical stage is specified through instrumental provision structured in accordance with the logic of the research process. At this level, the specific tools applied at each stage are clarified – from the preparation of materials to statistical processing and the presentation of results.

The instrumental provision of the empirical stage is constructed in line with the logic of the research process. It encompasses successive stages of preparation, data collection, processing and analysis, as well as the presentation of results. At the preparatory

stage, diagnostic instruments are selected and constructed, questionnaires, protocols and instructions are developed, and supporting visual and multimedia materials are prepared. Data collection is implemented through testing, interactive and online technologies, which ensure automated recording of responses and enable large-scale sample coverage. Subsequent processing and interpretation of results are carried out using specialised statistical software, making it possible to test hypotheses and to establish the validity and reliability of the data obtained. The final stage involves presenting results in the form of tables, graphs, charts, and visualisations, which ensure clarity and accuracy in the reporting of empirical findings. The general structure of the instrumentation and the sequence of its application are presented in the scheme (figure 4).

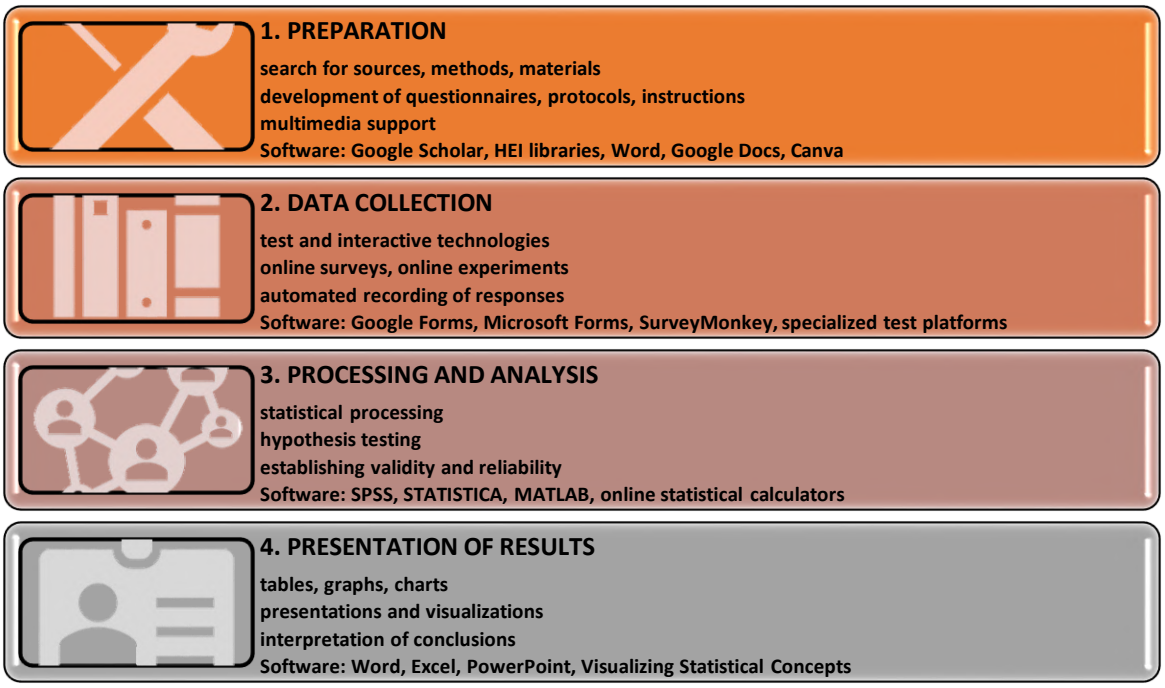

Figure 4: The content of the empirical stage of scientific pedagogical research

Within the empirical stage, measurement and data processing may be carried out using *different types of software*, depending on the research objectives, the level of complexity, and the requirements for procedural automation. First, custom software solutions may be employed, developed by the researcher or commissioned in accordance with the specific characteristics of the study object. Such solutions enable the instrumentation to be adapted as closely as possible to the content of the hypothesis, the structure of variables, and the logic of the experimental design. Second, ready-made software products for collecting and processing empirical data are widely used, providing standardised procedures for testing, questionnaire administration, and statistical analysis. Third, specialised cloud-based applications are becoming increasingly prevalent, enabling the organisation of remote measurements, the storage of results in online environments, and collaborative work with data. These include, in particular, platforms for online surveys and testing (Google Forms, Microsoft Forms, SurveyMonkey), services for experimental research and the construction of networks of related studies (PsyToolkit, Labvanced, Gorilla.sc), as well as web-based environments for psychological and educational experiments (PsychExps, Web Experimental Psychology Lab). The use of such resources creates the technical conditions for conducting research in both synchronous and asynchronous modes, with the possibility of scaling

samples and automating the recording of results.

A distinct direction of contemporary instrumental provision is the *individual design of digital measurement tools*, including the creation of thematic websites, interactive questionnaires or testing modules, as well as the use of artificial intelligence tools for constructing diagnostic materials. The development of specialised software may be commissioned, online instruments may be created independently, or artificial intelligence may be applied to generate questionnaire structures, adapt the wording of items, perform automated analysis of responses, and prepare preliminary statistical summaries. In this way, digital technologies not only automate routine operations but also expand the possibilities for designing research instruments in accordance with the authorial concept.

Thus, the instrumental provision of the empirical stage may combine custom software solutions, ready-made software products, and cloud-based platforms, which makes it possible to organise measurements flexibly, adapt procedures to the characteristics of the sample, and ensure the reliability, validity, and reproducibility of the results obtained.

4.3. Digital solutions at the stage of generalisation and implementation of research results

The stage of result generalisation involves systematising, interpreting, and practically representing the empirical data obtained, as well as their subsequent implementation in educational practice. At this stage, information and communication technologies perform not merely a supportive but a conceptually significant function, ensuring the transition from scholarly conclusions to applied educational products, open communication of findings, and feedback from target groups.

One of the main directions is the development of digital educational products that reflect the generalised outcomes of the research. Depending on the study's objectives, these may include distance-learning courses, electronic textbooks, interactive manuals, computer-based learning tools, or methodological platforms. The practical implementation of such products is possible through learning management systems (Moodle, Google Classroom, Canvas), platforms for creating online courses (Open edX, Coursera for Campus), as well as tools for developing electronic learning materials (H5P, Articulate, iSpring, Canva for Education). These environments enable the integration of textual, multimedia, and interactive components, allowing for the monitoring of users' learning activities and the evaluation of the effectiveness of implementing research results.

An important instrument for generalisation and piloting is the creation of experimental websites or thematic web resources that serve as platforms for presenting research materials, methodological guidelines, examples of practical application, and accompanying documentation. Such resources can be implemented through content management systems (CMS), such as WordPress, Google Sites, or Wix, which ensure the accessibility of materials, the timely updating of information, and opportunities for interactive engagement with users.

For the support of professional communication and the acquisition of feedback, online forums, webinars and discussion platforms organised via Zoom, MS Teams, Moodle Forums, Google Meet, specialised educational communities or socio-professional networks are effective. These forms of interaction make it possible not only to discuss experimental results but also to monitor the implementation process, adjust methodological decisions, and document any practical difficulties that arise.

A distinct aspect of the generalisation stage is the dissemination of research results and scholarly-methodological outputs, which is realised through publications in professional electronic outlets, the posting of materials in open scientific repositories,

the creation of presentation and video materials, and participation in scientific and practice-oriented online events. For this purpose, digital tools for data visualisation and presentation (PowerPoint, Canva, Prezi), video hosting services, and educational platforms are employed, ensuring wide accessibility and long-term preservation of results.

Thus, at the stage of generalisation, information and communication technologies ensure not only the systematisation and interpretation of findings but also their transformation into concrete educational products, the organisation of implementation, communication with the professional community, and the dissemination of scholarly and methodological developments, thereby conferring practical completeness and social significance on the research (figure 5).

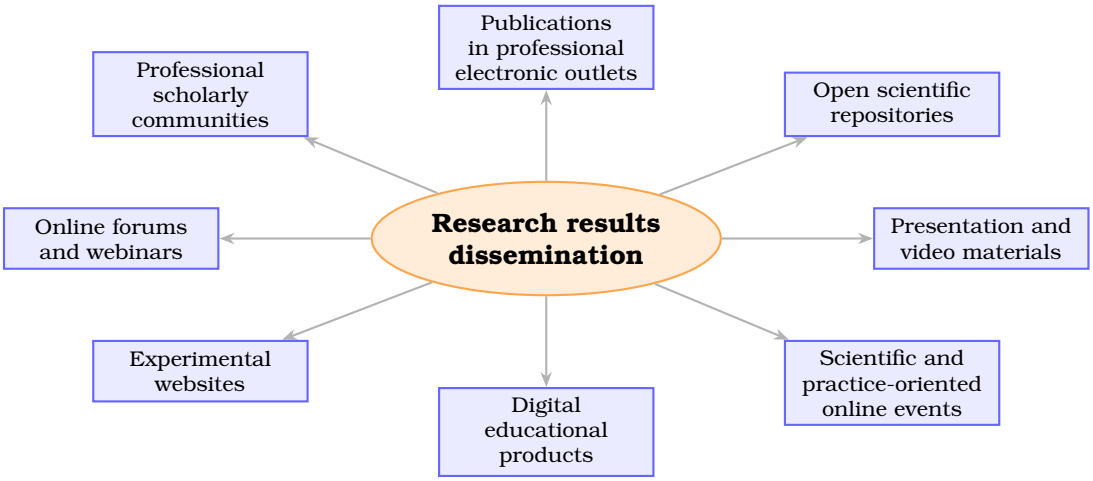

Figure 5: Ways to disseminate the results of scientific research.

Of particular significance at the stage of generalisation is the use of artificial intelligence tools that support the analytical, interpretative and representational components of research. Artificial intelligence can be utilised for the automated synthesis of results, thematic grouping of conclusions, preparation of analytical reviews and methodological materials, as well as for adapting educational content to different target audiences. In particular, it enables the creation of structured reports, the design of distance-learning course modules, the preparation of learning materials at varying levels of complexity, and the generation of visualisations and implementation analytics. Nevertheless, the use of artificial intelligence tools does not replace scholarly interpretation of results: final synthesis, conceptual comprehension, and the evaluation of the practical significance of conclusions remain the methodological responsibility of the researcher.

5. Discussion

The use of digital tools in educational research extends beyond purely technical support of research procedures and increasingly affects the very logic of organising the cognitive process. The automation of source retrieval, remote data collection formats, algorithmic processing of results, and digital visualisation alter the pace, scale, and form of research implementation. However, it remains of fundamental importance that technological means do not constitute methodology in themselves: the determination of the research object, the formulation of hypotheses, the selection of criteria and indicators, as well as the interpretation of results, fall within the sphere of scholarly responsibility. Under these conditions, digital tools should be regarded as a methodological resource that expands the possibilities of scientific analysis but does not replace its conceptual foundations.

The issue of validity and reliability of results in a digital environment requires particular consideration. On the one hand, online instruments ensure the standardisation of procedures, precision in data recording, reproducibility of calculations, and the possibility of engaging large samples. On the other hand, remote formats give rise to several methodological risks, including a lack of control over task conditions, self-selection of participants, the possibility of repeated participation, and the influence of extraneous factors on responses. In this context, increasing the number of respondents cannot be viewed as a universal compensator for methodological limitations. The decisive importance of a scientifically grounded research design remains: clearly defined sampling criteria, carefully devised control procedures, the combination of remote and face-to-face measurements, and a reflexive approach to interpreting the results obtained.

Artificial intelligence tools occupy a unique position in the contemporary technological landscape. Their use at the stages of information search, thematic grouping, initial synthesis, preparation of visualisations, and the design of educational content significantly enhances the efficiency of analytical work. Nevertheless, the limits of autonomy of such tools remain fundamental for educational research: artificial intelligence does not make methodological choices, does not generate scientific novelty, and does not evaluate the pedagogical appropriateness of conclusions. In this sense, it serves as a cognitive tool that supports intellectual operations but does not replace scholarly thinking. Recognition of this boundary constitutes a necessary condition for the responsible and ethically balanced use of intelligent technologies in research practice.

The practice of automated source retrieval and selection using artificial intelligence tools, which is primarily based on formal scientometric indicators, warrants particular critical reflection. Algorithmic systems increasingly rank results according to citation indices, impact factors, and inclusion in databases such as Scopus and Web of Science, thereby creating a temptation to substitute scholarly argumentation with quantitative metrics. Within such a logic, the relevance of research is often equated with its frequency of citation, while complex theoretical or methodologically alternative positions are displaced to the periphery of academic discourse. This contributes to superficial literature selection, a reduction in contextual analysis, and the formation of a reductionist approach in which the principle “those who are cited more are therefore right” effectively replaces critical engagement with sources.

Within the same context, the issue of the reliability of digital data and the risks of result fabrication becomes increasingly salient, intensified by the automation of search, processing, and text generation. Reliance on secondary analytical summaries, machine-generated reviews, or unverified datasets increases the likelihood of uncritical use of questionable or artificially constructed materials. Accordingly, the application of artificial intelligence tools in educational research must be accompanied by mandatory expert verification of primary sources, analysis of the methodological foundations of studies, comparison of different scholarly positions, and rejection of the automatic identification of scientometric indicators with scientific truth. Under these conditions, artificial intelligence may be regarded as an effective navigational instrument within large bodies of information, but not as a criterion of scholarly significance or evidential validity of results.

The application of digital tools at the stage of generalisation and implementation of results also raises the question of forms of scholarly representation. Research outcomes are increasingly materialised not only in the form of textual publications but also as digital educational products, including distance-learning courses, electronic textbooks, interactive platforms, experimental websites, and visual analytical materials. This broadens the channels for disseminating scholarly knowledge, strengthens

its applied orientation, and creates conditions for feedback from the professional community. At the same time, a methodological question arises: what should be regarded as the outcome of educational research – the conceptual model, empirically substantiated conclusions, or the digital product as a form of their implementation? It is evident that, within the contemporary scholarly context, these components are not opposed but rather complement one another, forming an integrated system of scientific and practical knowledge.

In summary, digital tools transform not only the technical dimension of research but also the culture of educational scholarship as a whole. Their effectiveness is determined not by the level of technological saturation, but by the degree of methodological rigour with which they are integrated into the research design. It is precisely the combination of digital possibilities with clearly articulated scholarly objectives, validity criteria, and responsible interpretation of results that ensures the productivity and scientific integrity of contemporary educational research.

6. Conclusions

The analysis conducted demonstrates that the use of contemporary digital tools should be regarded not as an auxiliary technical component but as a systemic element of organising educational research. At the theoretical stage, such tools provide access to expanded source bases, support structured work with literature, and facilitate the development of an individual research portfolio. At the empirical stage, they enable sample scaling, the automation of result recording, statistical processing, and data visualisation. At the stage of generalisation, digital tools allow research findings to be transformed into applied educational products (online courses, electronic manuals, experimental websites) and ensure feedback from the professional community.

It has been shown that the effectiveness of ICT use is determined not by the number of tools employed but by the logic of their integration into the research design. The main conditions remain a methodologically grounded sample selection, precise procedural staging, control of extraneous variables, and responsible interpretation of empirical data. The automation of data collection and processing, the use of cloud services, and specialised platforms increase the technical efficiency of research; however, they cannot compensate for methodological errors or substitute for the researcher's analytical decisions.

It is substantiated that artificial intelligence tools should be employed as means of intellectual support – for information retrieval, material structuring, result synthesis, and the preparation of analytical and educational products. At the same time, limitations of this approach are identified: the orientation of automated systems towards formal scientometric indicators (citation rates, inclusion in Scopus and Web of Science) may lead to superficial source selection, narrowing of analytical context, and the replacement of scholarly argumentation with quantitative indicators. A particular risk arises from the use of unverified or artificially constructed data, underscoring the need for mandatory expert verification of primary sources.

It is concluded that an optimal model is one in which digital tools, cloud-based platforms, and artificial intelligence are integrated into research as instruments subordinate to methodological logic. Such integration ensures not only technological efficiency but also scholarly accuracy, the validity of results, and the feasibility of their practical application in educational practice.

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