Effect of an Advanced Adaptive Learning System on developing the Digital Search Proficiency for Education Technology Branch Students

Prepared by

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Abstract: The aim of the current research was to examine the impact of using an advanced adaptive learning system on improving digital research competencies among Educational Technology students in Egypt. The main tools of the study included a proficiency test and an observation checklist for digital research skills. The experimental design used two groups: an experimental group with the advanced adaptive learning system and a control group. The primary tools were a test for cognitive aspects of digital research skills and an observation checklist for performance aspects. The sample consisted of 30 students from the Educational Technology Department at the Faculty of Education. One-way ANOVA was used to validate the research hypotheses. The results showed statistically significant differences between the mean scores of the experimental and control groups in favor of the post-test, confirming the effectiveness of the advanced adaptive learning system in enhancing digital research competencies among Educational Technology students.

Keywords: Advanced Adaptive Learning System, Digital Search Proficiency, Educational Technology Students.

Introduction:

The adaptation of the learning systems has become one of the core areas of recent interest. To achieve adaptation, we must consider the methods of learning, through which the learning system can adapt according to different learning styles. Therefore, the task of development has become essential for designers and includes many challenges in designing electronic learning systems (Waters, J. K., 2014, p. 12) .

It has become essential to equip university students with digital research skills for information retrieval, analysis, organization, and application of what they learn within the university to the outside world. This is necessary for universities to prepare their students for today's job market. On the other hand, the internet has gained significant importance in students' lives, as 38% of students rely on digital research for the ease of accessing information online, 34% for

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the novelty of the available information, and 70% for accessing information used in their daily lives. It has thus become crucial to leverage the vast amount of information available online in the educational process through research papers, reports, and articles (Kitikannakorn, N., & Sitthiworanan, C., 2009, p. 313).

Digital research allows beneficiaries to access information repositories and various informational sources and obtain them at any time and from anywhere with minimal effort, often without monetary cost (Abubakar, D., & Adetimirin, A. 2015). The researcher believes that an Advanced Adaptive Learning System can contribute to Improving Digital Search Proficiency among educational technology students in Branch of Egypt by providing content that aligns with their learning style, diversifying content elements within the System (text, images, graphics, and video), varying assessment methods, employing diverse reinforcement methods, incorporating activities within the System that align with the learning style, and enabling access to the teacher at any time .

By examining the results of the exploratory study conducted by the researcher, the reasons for the research became evident. The researcher conducted an exploratory study to assess the need for digital research skills among educational technology students by administering a questionnaire to a sample of (20) students in the educational technology department to measure their digital research skills. The results of the questionnaire showed that approximately (88%) of the students face difficulties in accessing digital databases and are unable to utilize them. They also lack the ability to search within databases. This led the researcher to provide an advanced adaptive learning system and utilize its multiple capabilities to overcome the challenges faced by learners.

Research Problem:

The research problem is identified as follows :

There is a deficiency in the cognitive and practical levels of digital research competencies among educational technology students. Necessitating the need for solutions, therefore the research aims to study the impact of using an advanced adaptive learning system on enhancing the efficiency of digital research skills among these students.

Research Questions:

The current study aimed to answer the following question:

What is the impact of using an advanced adaptive learning system on developing the efficiency of digital research skills among educational technology students"?

Research Hypotheses:

The current research sought to investigate the validity of the following hypotheses:

There is a statistically significant difference at a level ≤ 0.05 between the mean scores of the experimental group and the control group in the pre-test and post-test of the cognitive aspects related to digital research skills attributed to the primary effect of using an advanced adaptive learning system for educational technology students at the Faculty of Education in Ismailia in the e-learning unit and using the internet in the course "Introduction to Educational Technology".

There is a statistically significant difference at a level ≤ 0.05 between the mean scores of the experimental group and the control group in the development of the performance aspect of digital research skills attributed to the primary effect of using an advanced adaptive learning system for educational technology students at the Faculty of Education in Ismailia in the e-learning unit and using the internet in the course "Introduction to Educational Technology".

Study group:

The research group in its final composition consisted of (30) students from the third year of the educational technology department at the Faculty of Education, Suez Canal University. They were randomly selected and evenly distributed between the experimental and control groups according to the research's experimental design The experimental group consisted of)15(students, while the control group comprised (15) students.

Research Variables:

The research variables included the following:

Independent Variable: Advanced Adaptive Learning System and the regular teaching method.

Dependent Variable: Digital Research.

Research Methodology:

The researcher used an experimental approach to study the impact of an advanced adaptive learning system on improving digital research skills in the e-learning unit and the use of the internet in the "Introduction to Educational Technology" course among educational technology students at the Faculty of Education, Suez Canal University.

Research Tools:

The research included the following tools:

Measurement Tools: A cognitive aspects achievement test for digital research skills, prepared by the researcher, and a performance aspects observation checklist for digital research skills, also prepared by the researcher.

Experimental Intervention:

Advanced Adaptive Learning System.

Experimental Design:

The current research employed a two-group a quasi-experimental design, consisting of an experimental group and a control group. This design involves the application of research tools before the intervention, followed by the experimental treatment, and then the application of research tools after the intervention.

Research Scope:

The current research was limited by several boundaries, including:

Subject Boundaries: E-learning unit and the use of the internet in the "Introduction to Educational Technology" course.

Human Boundaries: Third-year educational technology students.

Geographic Boundaries: Faculty of Education in Ismailia, Suez Canal University.

Time Boundaries: The first semester of the academic year 2022/2023.

Research Objectives:

The current research aimed to achieve the following objective:

To design an advanced adaptive learning system and enhance it to align with educational technology students at the Faculty of Education, contributing to improving digital research skills while studying learning content through it.

Significance of the Research:

The significance of the research can be summarized as follows:

It aligns with modern educational trends that emphasize the importance of developing digital research skills and the learner's active role in the educational process, engaging in various activities during learning situations.

Research Terminology:

The current research includes several terms, which are:

Advanced Adaptive Learning System: It refers to an electronically based learning system that allows personalized learning for each student, according to their individual learning style, in order to enhance students' proficiency in digital research skills.

Digital Research Proficiency: Operationally, it refers to the skills associated with using information networks and digital information sources. These skills include, for example, the ability to use digital information sources, understanding search engines and how they operate, searching in digital databases, accessing desired data efficiently and effectively, and utilizing various research techniques. This proficiency is measured by the score a student obtains on the digital research skills observation checklist.

Theoretical Framework and Related Studies:

The investigator formulated the research's theoretical framework based on an analysis of pedagogical literature, in addition to precedent local, Arab, and international studies in three primary dimensions encompassing multiple facets of the study as described below:

Dimension 1: Concentrates on digital research competencies.

Dimension 2: Explores a sophisticated adaptive learning system.

Dimension 3: Investigates instructional design principles for an advanced adaptive learning system and their influence on optimizing digital research efficacy and the employed paradigm.

Firstly: Digital Research Competencies:

Rapid advancements in modern technological services have led to numerous changes in educational systems, affecting curricula, educational objectives, and teaching methods. The learning environment has shifted from traditional to digital, with heavy reliance on the internet, automated catalogs, and CDs for scientific communication, digital translation, data analysis, cloud storage, and other electronic services (Mohamed Omar Mohamed, 2018, p. 379).

Rapid technological advancements have highlighted the need to familiarize students and researchers in academic and educational institutions with the digital services necessary for research and study. It is crucial to equip them with skills for handling various types of information and conducting online research. A lack of training in modern information technologies can lead to suboptimal utilization of these tools and difficulties in obtaining reliable information. Furthermore, the rapid developments in information and communication technology have underscored the necessity of reviewing research materials across different theoretical and practical faculties, incorporating modern technological skills into research and study practices (Rima Saad Al-Jarraf, 2004, pp. 77-80).

The researcher argues that the inadequacy of research training for learners is attributed to insufficient practical training in digital research skills. Developing research skills requires a combination of theoretical knowledge and practical training, following a methodological approach that identifies learners' needs and then initiates training in research skills. The researcher will address the following points in this section:

A. Reasons for the shift towards developing digital research skills:

Reviewing previous studies: Many prior studies have addressed the training needs for digital research skills among university students. Below is an overview of key Arab and international studies related to the development of digital research skills in various academic programs within education faculties. The researcher did not follow a chronological order but rather a functional approach, discussing the studies from various perspectives in light of their agreement or disagreement with the current study and other studies, as follows:

The previous studies align with the current research objectives by exploring various applications of technology in scientific research and its benefits for the learning process. These include the studies by "Salah Jouhar, Murad Ibrahim" (2019), Mohamed Al-Muqayed" (2019), which addressed challenges in detecting scientific plagiarism in educational research, "Nafisa Qattaliya" (2017), which focused on using digital technology applications in scientific research, "Samia Sayad" (2017), which aimed at enhancing information literacy in managing references electronically, "Mansour Lekhdari" (2016), and "Nesreen Qabbani" (2017), which discussed the use of digital technology in scientific research and research quality criteria .

In light of the above and the results of previous studies on adaptive learning environments and their effectiveness in enhancing the educational process and meeting learners' needs according to their different learning styles, the researcher believes that an advanced adaptive learning system can contribute to the efficiency of digital research among educational technology students. This can be achieved by providing electronic content that aligns with each student's learning style, diversifying content elements within the system (such as texts, images, diagrams, and videos), defining the skills and analysis methods, and varying assessment and reinforcement methods. Additionally, it involves enhancing communication and collaboration during learning, accommodating synchronous and asynchronous interactions, utilizing activities that match learning styles, enabling access to instructors at any time, allowing for activity repetition to achieve goals, or providing a range of remedial activities.

B. Concept of Digital Research Competencies:

Many concepts related to digital research skills have been discussed by researchers and specialists in the field of educational technology. We will review the most important of these concepts and the concept of research skills as follows:

Kate Conway" delineated digital research competencies as "the pragmatic proficiencies requisite for learners to utilize technological apparatuses and implement them to expedite precise pedagogical research" (Conway, K. 2011).

Mohamed Omar Fattah" (2018, p. 388) defines it as: "The practical abilities required for learners to use technological tools and employ them in preparing educational research with speed and accuracy." It refers to: "The skills managed by the user to interact with internet-related services, where information is stored digitally and made accessible via the web" (William Arms, 2006, p. 20). It also means: "The skills needed by researchers, such as the use of electronic journals, digital libraries, and specialized databases" (Salwa Fathy Mahmoud, 2014, p. 14).

It is operationally defined as: "The ability to navigate the internet, access various digital information sources, use specialized databases, understand the workings of different search engines, and employ digital search operators to efficiently and effectively obtain desired data".

C. Digital Research Proficiencies:

Many studies have found that students face difficulties in accessing and evaluating information sources on the internet. This issue arises because many online information sources are unreliable and incomplete. Additionally, students often engage in incorrect research practices, such as copying and pasting research and articles verbatim from the internet without reading, summarizing, or properly citing the sources, which exposes them to academic dishonesty. Therefore, it is essential to train students in evaluating information sources (Walraven, A., Brand-Gruwel, S., & Boshuizen, H. 2009, 235; Credaro, A. 2002, 35-36). Acquiring digital research competencies is crucial for students' academic and professional futures, enabling them to navigate environments rich in diverse electronic information sources and learning tools. These competencies also play a significant role in shaping their interaction with information and with each other, meeting their educational needs, and providing active and flexible learning experiences through participatory teaching methods that integrate formal and informal education (Ezziane, Z. 2007, 180; Ching-Chiu, L. I. N. 2011, 13).

Rima Saad Al-Jarf" (2017, 101-104) expounded upon the digital research competencies that ought to be cultivated in students, upon which the present investigator has relied. These competencies encompass advanced research practices, whereby the investigator distills research within the pertinent field, elects research within a discrete domain or website, opts for an electronic compendium in the specialization, explores specialized scientific organization websites, designates specific search terminologies germane to the desired subject matter, and employs various search parameters that researchers depend upon to access electronic information repositories. There is an urgent need to develop digital competencies among educational technology students, as these competencies play a crucial role in advancing the field of scientific research and addressing many of the challenges researchers face. This is achieved through the following:

-Facilitating researchers' and university students' access to local and international information centers and research centers: Digital competencies enable access to the data and information necessary for their studies and research.

-Assisting researchers in accessing journals, magazines, and scientific references from anywhere in the world: Digital competencies allow researchers to obtain scientific resources and exchange research at low costs and with great speed.

-Providing an extensive and diverse range of information: Digital competencies help researchers and students access a vast array of information across various fields.

-Supporting researchers in publishing their scientific work: Digital competencies aid in the widespread dissemination of research, thereby broadening the impact and utility of scientific findings (Willoughby, T., et al., 2009, 640).

Reema Saad Al-Jarf (2017, pp. 101-104) discussed the digital research skills that should be developed among students, which were utilized by the researcher in her current study. These include:

-Advanced Search: This involves narrowing down the search to a specific field or site. Researchers can select from various domains such as (.org for U.S. and international organizations like NGOs), (.gov for U.S. government sites), (.edu for U.S. educational sites), (.gov.uk for UK government sites), (.ac.ca for Canadian academic sites), and (.org.au for Australian organizations like NGOs).

- Selecting an electronic subject-specific directory, such as:

-Translation Directory

- Social Science Directory

- Directory of Open Access Journals

- Searching specialized scientific association websites, such as:

- TESOL International Association

- American Translators' Association

- Federation of Arab Libraries

- American Psychological Association

- International Society for Technology in Education

- Economic Association

- International Association of Teachers of English.

- Selecting specific search terms related to the topic, and using synonyms to broaden or narrow the search.

- Enclosing search terms in quotation marks to get precise results on sites like Google Scholar and Google Books. For example: Author's name: "Nora Saad Al-Qahtani," Book title: "Artificial Intelligence in Education," Hadith excerpt: "Actions are judged by intentions," Topic: "Virtual Reality".

- Using various search operators as described by Khalid bin Matar Al-Zahrani (2015, pp. 12-15) to access electronic information sources on Google Scholar.

-Searching electronic databases using criteria such as Title, Author, Publisher, Subject, or Keywords.

- Specifying file types and publication years through advanced search techniques in digital libraries and specialized databases.

- Familiarizing with basic digital research terms and commands, such as: Citation, Abstract, Keyword, Search Results, Subject, Book Chapter, Newspaper, Document, Periodical, Index, Title, Guide, Help, Publication Date, Save, Submit, Print, Browse, Search, View, Accession Number, Continue, Login, Proceed, Unmark, Mark, Request, Obtain, Order, Previous, Clear, Next, Peer Reviewed Journal, Select, Main, Return To, Advanced Search, Basic Search, Field, Full Record, Author, Descriptor, Identifier, Journal, Language, Records, Full Text, Image, Collection, Refereed Journal.

- Browsing search results by reviewing study abstracts, article titles, and scientific research, examining subject indexes, and selecting relevant results to save on one's computer.

- Selecting the appropriate search result in specialized databases by marking it.

- Reviewing and verifying search results by checking the author's name, publisher, publication year, and location, whether through a blog, forum, personal website, or thesis. Ensuring that the information is authored by a qualified expert and has been peer-reviewed by specialists in the field. Verifying the currency, accuracy, and coverage of the information relative to the research topic, and ensuring it is included in the reference list. Checking if the websites used for information retrieval have extensions such as (gov, edu, com). Reviewing, reading, and summarizing reports and research, and providing opinions when using the information in research, with proper citation. Ensuring proper citation of books, research papers, and articles, including (author, publication year, title, place of publication, page numbers), using reference citations and maintaining alphabetical order in the references (Khalid bin Matar Al-Zahrani 2015, pp. 12-15).

D. Evaluating Digital Research Competencies:

Digital research competencies are appraised through three facets:

Cognitive Facet: Assessed using a cognitive examination addressing the knowledge components of the competency.

Performance Facet: Assessed using a practical performance observation rubric. Performance observation represents one of the most critical competency assessment methodologies as it elucidates the scope of performance enhancement and competency acquisition progression. Its objective is to explicate the performance facet, supervise, govern, systematize activities, and discern connections between performance

facets (Khabiri, M., & Marashi, H. 2016, 179-202). The investigator relied on conferring digital research competencies to students by advancing both the cognitive facet and the performance stratum of digital research proficiencies.

The researcher based her study on equipping students with digital research skills by enhancing both their knowledge and the performance level of their digital research abilities.

Secondly: Sophisticated Adaptive Learning Frameworks

"Although web-based e-learning environments offer many advantages to support the processes of teaching and learning, learners face some issues during learning through them. They do not take into account the individual differences between learners, nor do they consider learners' personal differences and educational needs. They present educational content to all learners in the same way according to a fixed learning path for everyone. This necessitates the provision of an adaptive learning environment that allows for diverse learning paths tailored to the different needs of learners (Klašnja-Milićević, A., Vesin, B., Ivanović, M., & Budimac, Z., 2011, 885-899; Mahnane, L., Laskri, M. T., & Trigano, P., 2013, 339)".

"Adaptive learning environments have become a key topic that has received significant attention recently. For a learning environment to be adaptive, it is essential to focus on learning styles. Through this, the learning environment becomes capable of adapting according to the different learning styles of learners (Mohamed El Mahdi, 2009, 67)".

"Just as learners have different needs that must be considered in web-based education, the e-learning course must align with and adapt to the varying desires and needs of learners throughout the course's progression. An adaptive e-learning system is a personalized system that supports adaptive interaction; it receives data from the user, uses a specific model, and then performs the adaptation. An e-learning environment is considered adaptive if it can act based on the knowledge it has about the learners, such as monitoring and interpreting learners' activities in light of each learner's specific domain model (Abdul Karim Al-Ashqar & Magdy Saeed Aql, 2009, 129-130)".

Despite the advantages and effectiveness of web-based learning in the educational process and the tools it provides to support teaching, there are some issues that learners face online. For instance, it presents content in the same way for all learners without considering their personal characteristics and previous experiences. Therefore, it was necessary to develop an adaptive web-based educational system that

offers different pathways to meet each learner's needs (Aleksandra, K., Boban, V., Zoran, B., 2011, 212).

Adaptation in designing e-learning environments adjusts the delivery of information according to the unique learning style of each learner, allowing them to progress based on their own abilities and receive immediate feedback. This is achieved through two important dimensions: first, an individual adaptive system that provides each learner with a learning plan based on their needs, interests, and characteristics; and second, the development of a learning environment model that requires a climate filled with various alternatives, tasks, activities, and available learning strategies (Abdul Aziz Mohamed Gouda, 2012, 231).

Both Abdul Karim Mahmoud Al-Ashqar and Magdy Saeed Aql (2009, 129-130) and Amira Atta (2010) recommended in their studies that learners have different needs, and these differences should be considered in web-based education. The e-learning course should be designed to align with and adapt to the needs and desires of learners throughout the course's progression. An adaptive e-learning system is considered a personalized e-learning system that supports adaptive interaction; it receives data from the user, uses a specific model, and then performs adaptation according to that model.

Adaptive learning is considered a promising alternative approach as it meets learners' individual needs by providing personalized knowledge. Adaptive learning involves determining a study path that fits learners' learning styles and preferences, and then designing course content suitable for each learner type based on their abilities, interests, and needs (Kostolányová, K., & Šarmanová, J., 2014, 172-182; Kara, N., & Sevim, N., 2013, 108).

Studies by Wolf (2007, 48), Lee, J., & Kim, D. G (2012, 794-801), emphasize the crucial role of adaptive learning systems in enhancing the educational process by identifying learner styles and creating a learning environment that can pinpoint learners' weaknesses and leverage their strengths

A. Concept of Sophisticated Adaptive Learning Framework:

A sophisticated adaptive learning framework refers to "a digital learning system that dynamically tailors itself to the learner's cognitive style and inclinations. Its architecture and design principles are grounded in pedagogical theories, learning models, remote education, and the implementation of artificial intelligence in educational settings" (Wolf, C., 2007, 160).

It refers to "Systems that allow learners the freedom to navigate through extensive spaces and rely on delivering content that aligns with the user's knowledge, readiness, and preferences according to a pre-existing user model" (Sami Abdel Wahab Saafan, 2010, 73).

It refers to "Educational systems that rely on artificial intelligence technologies to enhance learners' learning and help them achieve their educational goals'" (Phobun, P., & Vicheanpanya, J., 2010, 464).

"Adaptive and intelligent web-based educational systems (AIWBES) are systems that serve as alternatives to traditional educational systems by adapting to the learner's needs. They do this by defining a model for each learner that represents their goals, preferences, and knowledge of the curriculum. Adaptive and intelligent educational systems result from merging research on intelligent tutoring systems (ITS) with adaptive hypermedia systems (AHA)" (Brusilovsky, P., & Peylo, C., 2003, 156-169).

B. The Rationale for Sophisticated Adaptive Learning Frameworks:

One of the principal benefits of employing sophisticated adaptive learning frameworks over conventional learning systems lies in their capacity to acclimate to the pace and competencies of individual learners. These frameworks augment the learning experience by granting learners the autonomy to utilize web resources, applications, and tools within their educational milieu in accordance with their requirements and cognitive styles. These systems can accommodate the heterogeneous educational demands of learners, adjusting to fluctuating learning conditions, and amplifying interactivity via hyperlinks to accomplish the intended learning outcomes (Nicola, J. D., & Macfarlane-Dick, D., 2006, 199).

Adaptive learning systems are also characterized over traditional learning systems by their ability to adapt to the pace and skills of each learner and to facilitate the learning process. This requires attention to diagnosing the learning process and employing modern technology to enhance and develop these systems. To illustrate how learners adapt to educational activities, the system updates each learner's profile by tracking their learning paths and interactions with digital content and the system itself. Through a diagnostic strategy, the adaptive tool (Adapte) within the system provides activities tailored to different learner paths. Based on this, educational activities are presented in a personalized manner according to each learner's profile.

The system updates the learner's profile and creates new activities based on the analysis of each learner's paths and interactions with new activities (Guin, N., & Lefevre, M., 2013, 141-142). The Next Figure illustrates the adaptive tool process and the adaptation of intelligent educational systems, including the update of each learner's profile

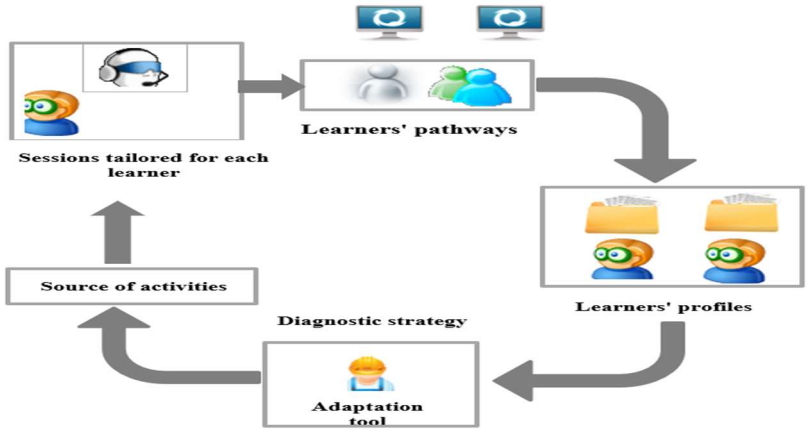

Figure The process of the adaptation tool and the adaptation of smart education systems and updating each learner's profile (modified).

C. Advanced Adaptive Learning System Technologies:

Adaptive Presentation: refers to adjusting the content of a page within adaptive e-learning environments by tailoring the presentation of multimedia (Adaptive Multimedia Presentation) or text (Adaptive Text Presentation) according to the learners' needs. Several technologies support this adaptation, including:

A. Adapting the Parts of the Content: This involves adjusting and organizing the presentation of parts of the educational content (e.g., content, exercises, activities, summaries, post-tests) according to each learner's learning style, based on their responses to a "learning style guide" questionnaire. Rather than presenting fixed pages and content types, this approach considers each learner's individual learning style to deliver the educational material in an engaging manner Examples of adapting content sections include the following:

-Miscellaneous Pages: These link course concepts to a variety of pages, which are presented based on the learner's preferred content type—textual or visual—or according to the learner's cognitive level, whether low, medium, or high, or based on their learning style.

-Miscellaneous sections: These divide each page of the adaptive learning environment into several sections, where different content is prepared for each section. The appropriate content is selected based on the learning style and characteristics of each learner (Carla, R. Landsberge, 2010, p. 65) .

-Conditional Text: This divides educational content concepts into segments of text, with each segment linked to a condition that indicates the type and level of the learner, such as beginner, intermediate, or expert .

-Stretch Text: This provides additional information related to a topic through active links or hot spots that learners can click on (Masoun Nabhan Hamssi, 2010, pp. 99-103).

B. Adaptive Navigation: This aims to support the learner's navigation through the course pages within adaptive learning systems by tailoring the navigation links according to their cognitive level and goals (Carla, R. Landsberge, 2010, p. 32). Adaptive navigation is achieved through the following:

-Direct Guidance: This is one of the simplest methods of adaptive navigation, where the learner is directed to the next best link or node they need to visit. Direct guidance is used in educational systems that implement curriculum-tracking technology.

-Mapping: In this method, a map or tree is presented to reflect the overall structure of the educational material for the learner. It also shows the learner's current position within the course. Techniques such as feedback, direct guidance, and hiding links are used to support the presentation of curriculum maps (Masoun Nabhane Hamsi, 2010, p. 106).

-Links Sorting: This method involves reorganizing the links on the pages of an adaptive learning system according to the learner's model and attributes. This technique is used only with non-contextual links, which are unstable links. Links sorting helps reduce the time needed to reach the objective by placing the most relevant links at the beginning of the link list. Therefore, it is commonly used with information retrieval systems.

-Links Hiding: This technique helps manage the amount of information available within the navigation space to reduce the cognitive load on the learner. It is used with index links, map links, and all types of non-contextual links, which render the links unstable. This is done by converting contextual links from clickable hot words to plain text or hiding some menu items. It involves concealing educational

concepts for which the learner has not yet achieved an intermediate level of understanding, according to the rules set and used by the instructor (Carla, R. Landsberge, 2010, pp. 36-40).

Thirdly: Establishing Instructional Design Principles for Advanced Adaptive Learning Systems and the Utilized Model in Development

The compilation of principles was conducted by the researcher through examination of Arabic and international studies, theoretical frameworks, literature, and subsequent recommendations. These principles encompass target audience specifications, interaction interface design for instruction, instructional control mechanisms, learning objectives, pedagogical content, educational activities, evaluation processes, and standards affiliated with supporting measures deployed by educational systems for learners.

The applied model for designing an advanced adaptive learning system:

The researcher selected the model formulated by "Mohamed Ibrahim Eldesouki" (2015) for instructional design and development, specifically tailored for this category of e-learning. It is optimally suitable for the current research's context, with minor alterations incorporated into the model to synchronize with the ongoing research.

Research Methodology and Instruments:

Primary Component: Design and Development of the Sophisticated Adaptive Learning System

The investigator chose the framework put forth by "Mohamed Ibrahim Eldesouki" (2015) for instructional design and development. This framework comprises of seven principal phases, each encompassing multiple sub-processes, as follows:

Input Evaluation Phase: Entails the identification and quantification of learners' input necessities.

Preparation Phase: Conducts an analysis of learners' prior interaction with computer systems and internet technologies, identification of essential prerequisites, and determination of the technological infrastructure required for the sophisticated adaptive learning system.

Analysis Stage: The stage encompasses problem scrutiny and needs assessment, pinpointing gaps in cognitive aptitude and digital research skillsets among educational technology students. It also determines the overarching learning objectives for the advanced adaptive learning algorithm content, such as recognizing digital

information sources and their utilization in higher education, comprehending electronic database research methodologies, and acquiring proficiency in Google search engine usage.

Educational Design Stage: This phase entails the formulation of meticulous procedural objectives for the digital educational material, devising suitable content delivery through the advanced adaptive learning algorithm. The content was subdivided into digestible topics and integrated into the system. Various multimedia instruments were employed, and the content was linked to the web-based advanced adaptive learning algorithm. Communication tools and pedagogical services were utilized, managing user registration, exit procedures, and permissions.

Production and Development Stage: This stage involves the construction of an advanced adaptive learning algorithm through server reservation for uploading all necessary components, incurring an annual financial expenditure. It comprises interactive interface production, multimedia element generation, electronic educational material creation, and integration with the advanced adaptive learning algorithm. Synchronous and asynchronous communication tools were used via software applications like Microsoft Visual Studio, Adobe Photoshop CC 2022, and Articulate.

Evaluation Stage: This phase includes preliminary assessments of the adaptive learning ecosystem by educational technology experts. Content underwent review by specialized professionals in the field of educational technology and was prepared in its final iteration. Electronic educational material was developed alongside research tools, encompassing a cognitive evaluation for measuring digital research skill-related cognitive facets and an observation record for assessing digital research skill performance levels. A paper-based iteration of these instruments transitioned to an electronic format within the advanced adaptive learning algorithm.

Publication and Availability for Final Use: Upon executing requisite modifications to the platform, learners within the domain had access to the system.

Development of evaluation instruments:

First assessment tool: Cognitive Assessment Exam:

The construction of the cognitive assessment exam involved these processes:

Defining Exam Objectives: The purpose of this assessment was to gauge cognitive dimensions of digital research competencies among a

cohort of educational technology pupils enrolled in the course, "Introduction to Educational Technology and Internet Utilization in Education".

Determining Item Type: Multiple-choice queries were chosen as the preferred item type for this exam.

Preliminary Assembly of Cognitive Assessment Exam: The primary edition of this exam encompassed 100 items, assessing three tiers of cognitive processing - retrieval, comprehension, and application.

Establishing Exam Validity: Validity was ascertained through multiple techniques:

Expert validation: Scholars with expertise in educational technology examined the exam.

Self-validation: The internal validity coefficient for the assessment in this study was determined to be 0.91, signifying high internal validity.

Reliability examination: Cronbach's alpha was computed to gauge the exam's reliability, resulting in a value of 0.83, denoting strong reliability.

Item Analysis: The item analysis procedure scrutinized the quality of exam components.

Determining Exam Duration: Total time required to complete all exam components was calculated using this formula: Total time to answer all test questions = Summation of individual learner's time / Number of learners = 900 minutes / 5 students = 180 minutes. This duration was assigned for responding to the exam questions.

Digital Production of Cognitive Assessment Exam: Visual Studio Code was used for formulating, programming, and electronically generating the test components.

The cognitive assessment exam aimed to evaluate digital research capabilities' cognitive facets among the educational technology student sample. Its validity and reliability were established to ensure its efficacy as an evaluative instrument.

Continuing with the development of the assessment instrument and the pilot study

Second assessment tool: Digital Research Skills Notecard:

To construct the digital research skills observation card, the following steps were executed:

1.Establish the Objective of the Digital Research Skills Observation Card: The primary aim of this tool was to evaluate the performance of educational technology students in the current study sample concerning digital research competencies within the

"Introduction to Educational Technology and the Use of the Internet in Education" course.

2.Identify Sources for Developing the Digital Research Skills Assessment: The competencies included in the assessment were determined by reviewing existing digital research skillsets..

3.Determine the competencies integrated into the digital research skills assessment tool: The final version of this tool included three core competencies for digital research, which were subdivided into 60 sub-competencies.

4.Develop Digital Research Skills Assessment Tool Items: The items within the assessment tool were designed as a series of behavioral milestones.

5.Prepare an Initial Draft of the Digital Research Skills Assessment Tool: A preliminary draft of this tool was created before making revisions and presenting it to domain experts for validation to ensure its accuracy and reliability.

6 .Deliver Clear and Unambiguous Instructions: Specific guidelines for using this digital research skills assessment tool were drafted to ensure clarity.

7 .Determine Scoring Criteria for the Digital Research Skills Assessment Tool: The scoring system for this tool was established using a quantitative scale.(١-٢-٣-٤)

8 .Revise and Finalize the Digital Research Skills Assessment Tool: To ensure its validity and reliability, revisions were made to this assessment tool by verifying its validity and reliability coefficients. In this study, an internal validity coefficient of 0.91 was achieved, indicating a high degree of internal validity. Additionally, the Cronbach's alpha calculated for reliability was 0.85, indicating good reliability.

Thirdly: Preliminary Investigation

The preliminary investigation was executed on a limited subset of participants to evaluate the efficacy of the observation card. This subset included 5 randomly selected students, representing the primary research population. The investigation transpired during the first semester of the academic year 2022/2023.

This preliminary assessment facilitated the optimization and validation of the observation card before its full-scale deployment in the main research study, additionally ensuring its validity and reliability in assessing digital research competencies among educational technology learners.

Main Experiment Execution:

The primary experimental procedure was performed over a one-month duration, commencing in November of the academic year 2022/2023. The following methodology was employed:

Preparation of primary study apparatus: The investigator assembled materials and instruments for experimental processing, generating a roster of usernames and passwords for each participant.

Establishment of research cohort: The final research cohort comprised 30 third-year students from the Technology of Education department for the academic year 2022-2023. These individuals were segregated into two distinct groups—control and experimental—according to the research's experimental design.

Initial application of research instruments to the research cohort.

Execution of experimental processing: A consensus was reached with participants that experimentation would ensue three weeks post-initiation.

The following table illustrates the timeline for the study of educational modules delivered through an advanced adaptive learning system:

Session	Educational Content	Application Days	Time Period	Number of Sessions
First	Introductory Meeting for Students	Sunday	3/12/2023	1
Second	Preliminary Application of Study Tools	Monday	4/12/2023	2
Third	Module 1: E-Learning and Internet Applications in Research and Education	Tuesday	5/12/2023	2
Fourth		Wednesday	6/12/2023	2
Fifth		Thursday	7/12/2023	2
Sixth	Module2: Research Methods in Electronic Databases and Their Stages	Sunday	10/12/2023	2
Seventh		Monday	11/12/2023	2
Eighth		Tuesday	12/12/2023	2
Ninth		Wednesday	13/12/2023	2
Tenth	Module 3: Mechanisms for Using Google Search Engine	Sunday	17/12/2023	2
Eleventh		Monday	18/12/2023	2
Twelfth		Tuesday	19/12/2023	2
Thirteenth		Wednesday	20/12/2023	2
Fourteenth	Applying Post-Study Tools	Thursday	21/12/2023	2

By this point, all learners had concluded their content studies and expressed preparedness for post-application.

Subsequent application of research instruments to the research cohort.

Statistical data manipulation: Quantitative data analysis was conducted utilizing the Statistical Package for Social Sciences (SPSS).

Results and discussion:

This section delineates the quantitative outcomes pertinent to the postulations and discoveries procured via the principal investigational trial, addressing the research inquiry. Furthermore, it encompasses the explication of these outcomes, along with recommendations and proposed inquiries derived from the acquired findings and methodological configuration utilizing the Statistical Package for the Social Sciences (SPSS) software.

Firstly: Quantitative Analysis for Validating the First Hypothesis:

The investigator employed a t-test statistical method to ascertain the validity of the first hypothesis, positing, "There exists a statistically significant discrepancy at a level ≥ 0.05 amid the mean scores of the experimental group and control group in enhancing the cognitive facet of digital research abilities attributed to the primary influence of utilizing a cutting-edge adaptive learning framework for Educational Technology students at the Faculty of Education in Ismailia University within the e-learning module and Internet utilization in education as part of the foundational course in Educational Technology." This is demonstrated in the subsequent table:

Level of Significance	Calculated T value	Degrees of freedom	standard deviation	average	Sample size	group	level
A function at the 0.01 level	53.13	29	1.76	7.80	12	control group	Achievement Test
			1.88	19.00	12	experimental group	

To assess the validity of the given hypothesis, an independent samples t-test was employed by the researcher to juxtapose the mean scores acquired by students in both the experimental and control

groups in relation to their performance in the achievement examination. A perusal of the antecedent tabular data reveals that the computed "t" value surpasses its tabulated counterpart, with a significance level of 0.01 and 29 degrees of freedom. The tabulated "t" value equates to 2.76. Due to this statistically significant discrepancy favoring the experimental group, there exists a noteworthy divergence between these students' average scores in comparison to those in the control group concerning the cognitive facet of digital research aptitudes, with an advantageous skew towards the experimental faction.

Subsequently: Statistical Outcomes for Validity Examination of the Second Hypothesis:

To validate the second hypothesis, which postulated, "A statistically significant distinction (α ≥ 0.05) manifests between the average scores attained by students within both experimental and control cohorts in terms of enhancing their digital research skillset's performance dimension; this difference is ascribed to employing an advanced adaptive learning system within Educational Technology students at Ismailia University's Faculty of Education e-learning confines alongside utilization of internet resources in an introductory course focusing on Educational Technology", a t-test was implemented. This is illustrated sequentially in the adjoining table:

Significance level	Calculated T value	Degrees of freedom	standard deviation	average	Sample size	group	level
A function at the 0.01 level	54.23	28	1.13	5.80	12	control group	remark card
			2.88	25.00	12	experimental group	

Utilizing an independent samples t-test, the researcher evaluated the hypothesis by contrasting the mean scores of students in the experimental and control groups regarding the performance domain of digital research aptitudes, as assessed by the observation card. As demonstrated in the preceding table, the computed "t" value surpasses the tabulated "t" value, which was scrutinized at a significance threshold of 0.01 and 29 degrees of freedom. The tabulated "t" value is 4.76. This statistically substantial variance in favor of the experimental group signifies a statistically relevant contrast between the mean grades of students in both experimental and control groups on the observation

card for digital research skill performance aspects, favoring the experimental cohort.

Secondly: Exposition and Elucidation of Outcomes:

The adaptive learning environment's efficacy for Educational Technology students is apparent from the yielded data. Statistically significant disparities were observed between mean scores in post-test evaluations of students in experimental and control groups, with a preference towards the experimental group. The researcher ascribes this finding to adaptive learning system characteristics and associated guidelines.

The designed adaptive learning structure's contribution to learners' comprehension and assimilation of data in this study enhances persistence, determination, motivation for learning, and effective handling of educational processes. This impact is evident in student performance and development of digital research competencies and aligns with Sywelem et al. (2010) and French et al. (2007)'s findings that stress the value of distinct learning styles. Each learner possesses a unique style that differs in acquiring, comprehending, processing, retaining, and applying information; thus, recognizing these learning styles can lead to enhanced outcomes in educational progression.

The modern, adaptable learning system developed in this study creates a personalized classroom environment tailored to each student's learning preferences. This approach encourages students to consistently adhere to instructions and attend sessions according to the established timetable. As a result, this positively influenced the overall performance of the experimental group and improved their digital research skills. These skills were adapted to meet the students' everyday needs, fostering proficiency in line with the studies by Vassileva (2012), Mahnane, Laskri, and Trigano (2013), Franzoni and Assar (2009), and Nainie et al.(2010).

Expanding on this, the researcher posits that implementing an advanced adaptive learning system for the "Introduction to Educational Technology" course enables students to learn in harmony with their preferred style. This approach fosters more interactive practice of learning activities and execution of assigned tasks to fulfill learning goals. By providing a supportive educational atmosphere, learners' self-confidence is boosted, leading to improved performance in teaching and learning contexts. It also helps develop digital research competencies among the educational technology students within the current study sample.

The previous results clearly demonstrate the effectiveness of the adaptive learning system for Educational Technology students. The analyses revealed statistically significant differences between the mean scores of post-intervention tests for the experimental and control groups, with a preference for the experimental group. This distinction is attributed to the features of the adaptive learning system, which enhances understanding and assimilation, increases student motivation, and positively impacts their performance in research skills.

Recommendations:

Considering the research findings, the subsequent suggestions can be put forth to advance adaptive learning systems and bolster digital research capabilities:

1 .Introduce continuous training and growth programs to integrate adaptive learning systems into instruction and course delivery within the Educational Technology Department. This implementation would markedly enhance students' cognitive skills and their performance in digital research abilities.

2 .Infuse digital research competencies into university courses as these skills play a vital role in improving students' academic and research potential.

3 .Accord priority to the advancement of adaptive learning systems in higher education through collaboration with experts in the field and adhering to the guidance of the Ministry of Higher Education. This effort seeks to create dynamic scientific settings for researchers and inspire their involvement in science-driven knowledge structures.

4 .Incorporate adaptive learning systems into the strategic planning for scientific research projects and endeavors, as well as Egyptian educational enrichment initiatives, to accomplish learning objectives effectively and efficiently.

References

Abdul Aziz Mohamed Gouda (2012). Designing Electronic Courses with Navigation Models (Hierarchical-List) and Learning Styles (Divergent-Convergent) and Their Effectiveness on Achievement and Practical Skills of Students at the Gulf Arab University. Thirteenth Scientific Conference: E-Learning Technology - Contemporary Trends and Issues, April, 217-244.

Abdul Karim Mahmoud Al-Ashqar, Magdy Saeed Aql (2009). Developing the Adaptive Performance of the Educational Content Management Program (Moodle) at the Islamic University. Series of Natural and Engineering Studies. Gaza, 17(2), 123-150, Retrieved From : http://cutt.us/yjzf5

Abubakar, D., & Adetimirin, A. (2015). Influence of computer literacy on postgraduates' use of e-resources in Nigerian University libraries.

Aleksandra, K., Boban, V., Zoran, B.(2011): Integration of Recommendations and Adaptive Hypermedia into Java Tutoring System, ComSIS, Vol. 8, No. 1.

Barr, V., & Stephenson, C. (2011). Bringing computational thinking to K-12: What is involved and what is the role of the computer science education community?. Acm Inroads, 2(1), 48-54.

Brusilovsky, P., & Peylo, C. (2003), 'Adaptive and Intelligent Web-Based Educational Systems', International Journal of Artificial Intelligence in Education (IJAIED), 13, 156-169.

Carla, R . Landsberge (2010). Adaptive Training Considerations for use in Simulation Based Systems. SPECIAL REPORT . Orlando University.

Ching-Chiu, L. I. N. (2011). A learning ecology perspective: School systems sustaining art teaching with technology. Art Education, 64(4), 12-18.

Conway, K. (2011). How prepared are students for postgraduate study? A comparison of the information literacy skills of commencing undergraduate and postgraduate information studies students at Curtin University. Australian Academic & Research Libraries, 42(2), 121-135.

Credaro, A. (2002). Now we've got the Internet, why do we still need school libraries?. Principal Matters, (53), 35-36.

Ezziane, Z. (2007). Information technology literacy: Implications on teaching and learning. Educational Technology & Society, 10(3), 175-191

Franzoni, A. L., & Assar, S. (2009). Student learning style adaptation method based on teaching strategies and electronic media. Educational Technology & Society, 12(4), 15-29

French, G., Cosgriff, T., & Brown, T. (2007). Learning style preferences of Australian occupational therapy students. Australian Occupational Therapy Journal, 54(S1), S58 - S65. https://doi.org/10.1111/j.1440-1630.2007.00723.x

French, G., Cosgriff, T., & Brown, T. (2007). Learning style preferences of Australian occupational therapy students. Australian Occupational Therapy Journal, 54(S1), S58 - S65. https://doi.org/10.1111/j.1440-1630.2007.00723.x

Guin, N., & Lefevre, M. (2013). From a customizable ITS to an adaptive ITS. In Artificial Intelligence in Education: 16th International Conference, AIED 2013, Memphis, TN, USA, July 9-13, 2013. Proceedings 16 (pp. 141-150). Springer Berlin Heidelberg.

Kara, N., & Sevim, N. (2013). Adaptive learning systems: Beyond teaching machines. Contemporary Educational Technology, 4(2), 108-120.

Khabiri, M., & Marashi, H. (2016). Collaborative Teaching: How Does It Work in a Graduate TEFL Class?. TESOL Journal, 7(1), 179-202.

Khalid bin Matar Al-Zahrani (2015). Skills in Searching Electronic Information Sources. Saudi Arabia, King Saud University, p53.

Kitikannakorn N. & Sitthiworanan C. (2009). Searching for health information on the Internet by undergraduate students in Phitsanulok, Thailand. International Journal of Adolescent Medical Health, 21(3), 313.

Klašnja-Milićević, A., Vesin, B., Ivanović, M., & Budimac, Z. (2011). E-Learning recommendation strategy and learning style identification. personalization based on hybrid Computers & Education, 56(3), 885-899. DOI:10.1016/j.compedu.2010.11.001

Kostolányová, K., & Šarmanová, J. (2014). Use of Adaptive Study Material in Education in E-Learning Environment. Electronic Journal of e-Learning, 12(2), 172-182.

Lee, J., & Kim, D. G. (2012). Adaptive Learning System Applied Bruner'EIS Theory. IERI procedia, 2, 794-801.

Mahnane, L., Laskri, M. T., & Trigano, P. (2013). A model of adaptive elearning hypermedia system based on thinking and learning styles. International Journal of Multimedia and Ubiquitous Engineering, 8(3), 339-350.

Mahnane, L., Laskri, M. T., & Trigano, P. (2013). A model of adaptive elearning hypermedia system based on thinking and learning styles. International Journal of Multimedia and Ubiquitous Engineering, 8(3), 339-350.

Masoon Nabhan Jebreini (2010). An Intelligent Interactive System for Web-Based Education. Unpublished Ph.D. Dissertation, Faculty of Science, University of Aleppo, Syria, pp. 99-100.

Mohamed El Mahdi Abd El Rahman (2009). The Effect of Different Teaching Control Styles on the Effectiveness of Hypermedia Modules in Developing Programming Skills, Unpublished PhD Dissertation, Institute of Educational Studies and Research, Cairo University, Giza".

Mohamed Ibrahim Eldesouki, Mohamed Zidan Abdel Hamid, Yasser Said Al-Jaberti, Mina Wadih Girgis (2015). "Adaptive Support as a Design Variable in E-Learning Environments and Its Impact on Developing Programming Skills Among Educational Technology Students," University of Menoufia, Faculty of Education, Journal of the Faculty of Education, Vol. 33, pp. 58-60.

Mohamed Omar Mohamed Flatta (2018). Training Needs for Digital Research Skills Among Postgraduate Students in the Education Department at the Islamic University of Madinah: A Field Study, Journal of the Faculty of Education, Menoufia University, Vol. 33, No. 2, pp. 376-434.

Nainie, Z., Siraj, S., Abuzaiad, R. A., & Shagholi, R. (2010). Hypothesized learners' technology preferences based on learning styles dimensions. The Turkish Online Journal of Educational Technology, 9(4), 83-93

Nicola, J. D., & Macfarlane-Dick, D. (2006). Formative assessment and self-regulated learning: a model and seven principles of good feedback practice. Studies in Higher Education, 31 (2), 199–218.

Phobun, P., & Vicheanpanya, J. (2010). Adaptive intelligent tutoring systems for e-learning systems. Procedia-Social and Behavioral Sciences, 2(2), 4064-4069.

Rima Saad Al-Jarf (2017). Skills of integrating electronic information sources into the educational process at the university level, Journal of King Fahd National Library, College of Languages and Translation, King Saud University, Volume 23, P1, 90-122

Rima Saad Al-Jarraf (2004). A Proposed Concept for Teaching Electronic Research in Saudi Universities, King Fahd National Library Journal, Vol. 10, No. 1, pp. 76-89.

Salwa Fathy Mahmoud El-Masry (2014). "Differences in Teacher-Student Communication Patterns During Knowledge Journeys and Their Impact on Developing Digital Research Skills, Cloud Computing, and Knowledge Management for Graduate Students." Egyptian Society for Educational Technology, Vol. 24, No. 3, pp. 5-83.

Sami Abdel Wahab Saafan (2010). The Impact of Integrating Intelligent Education Systems with Adaptive Hypermedia in E-Learning Management Systems on Developing Innovative Thinking Skills. The 6th Scientific Conference of the Arab Society for Educational Technology: Digital Solutions for Learning Communities, in collaboration with the Institute of Educational Studies, Cairo University, Cairo, November 3-4, Research Proceedings, 68-98.

Sywelem, M., Dahawy, B., & Wang, C. H. (2010). An Examination of Learning Style Preferences among Egyptian University Students. Online Submission, 1, 16-23.

Vassileva, D. (2012). Adaptive e-learning content design and delivery based on learning style and knowledge level. Serdica Journal of computing, 6, 207-252

Walraven, A. Brand-Gruwel, S. &Boshuizen, H. (2009). How students evaluate information and sources when searching the world wide web for information. Computers & Education, 52(1), 234-246.

Waters, J. K. (2014). Adaptive learning: Are we there yet?. THE Journal (Technological Horizons In Education), 41(4), 12.

William Arms (2006). Digital Libraries. Riyadh: Translated by King Fahd National Library.

Willoughby, T., Anderson, S., Wood, E., Mueller, J., & Ross, C. (2009). Fast searching for information on the internet to use in a learning context: The impact of domain knowledge. Computers & Education, 52(3), 640-648.

Wolf, C. (2007). Construction of an adaptive e-learning environment to address learning styles and an investigation of the effect of media choice unpublished doctoral dissertation, School of Education, RMIT University Workshop Teaching Robotics, Teaching with Robotics & 5th International Conference Robotics in Education, Padova (Italy) July 18, pp. 43-50.

أثر نظام تعلم تكيفي مُتقدم في تنمية كفاءة البحث الرقمي لدى طلاب شعبة تكنولوجيا التعليم

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المستخلص: هدف البحث الحالي إلى فحص تأثير استخدام نظام تعلم تكيّفي مُتقدم على تحسين فعالية كفاءة البحث الرقمي بين طلاب تكنولوجيا التعليم في مصر. تمثلت الأدوات الرئيسة للدراسة في اختبار تحصيلي وبطاقة ملاحظة مهارات البحث الرقمي، وقد تم استخدام التصميم التجريبي ذو المجموعتين التجريبية والضابطة حيث تضمن التصميم التجريبي متغير مستقل تمثل في نظام تعلم تكيّفي مُتقدم, وجاء المتغير التابع ليتضمن مهارات البحث الرقمي. تمثلت الأدوات الرئيسة للبحث في اختبار تحصيلي لقياس الجوانب المعرفية لمهارات البحث الرقمي, وبطاقة ملاحظة الجوانب الأدائية لمهارات البحث الرقمي, تكونت عينة البحث من (٣٠) طالبا وطالبة من طلبة شعبة تكنولوجيا التعليم بكلية التربية. وتم استخدام اختبار تحليل التباين أحادي الاتجاه للتحقق من صحة فروض البحث. أوضحت النتائج وجود فروق دالة إحصائيًا بين متوسطي درجات طلاب المجموعة التجريبية والضابطة لصالح التطبيق البعدي مما يؤكد فاعلية نظام تعلم تكيّفي مُتقدم في تنمية كفاءة البحث الرقمي لدى طلاب تكنولوجيا التعليم.

الكلمات المفتاحية: نظام تعلم تكيّفي مُتقدم، كفاءة البحث الرقمي، طلبة تكنولوجيا التعليم.