Use of Smart Learning Resource Management Systems for Sustainable Learning

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Abstract—Technology advancements have an impact on how educational resources are used, which promotes learning for sustainable development. In contrast, open-learning resources were limited to collecting the necessary information for a variety of learners. The purpose of this research is to develop and study Smart learning re-source management systems: SmartLearnX, STOU. Before being tested on bachelor's degree students enrolled in an online course emphasizing nanolearning style offered by an open university in Thailand, the system passed a quality control examination by a team of 15 specialists. The sampling group was 65 students from Humanities and Social Sciences, Science and Technology, and Health Science. They were given a pretest before and after using STOU SmartLearnX in the course, and their mean scores were compared by t-test dependent and one-way ANOVA. Mean posttest scores were statistically higher than pretest levels, but there was no significant difference in posttest scores to students in the group. The purpose of this research was to create the initial smart learning resource management systems that were necessary for accessing the learning resources. In the future, the technology could be developed to provide more precise results by utilizing advanced searches and photos. Searches should take into account the context and should be responsive.

Keywords—online learning, open educational resources, search engine, life long learning, sustainable learning

1 Introduction

The primary factor that determines the quality of education is lifelong learning, which facilitates the acquisition of knowledge and relevant skills necessary for sustainable development [1][2]. The advancement of science and technology has led to the increasing use of digital platforms for educational purposes and to support learning procedures [3][4]. With the expansion of learning resources, it has become essential to utilize information and communications technology (ICT) in the learning process [5][6]. Open learning and distance learning resources have been acknowledged to be highly beneficial for learners of all ages, contributing to the achievement of sustainable development goals, particularly goal number four, which aims to provide equitable and

enhanced education for all learners. Open learning resources offer lifelong learning opportunities that can be accessed anytime, anywhere, allowing learners to follow up on any areas of interest or importance. By utilizing these resources, learners can acquire new knowledge and apply it to further their self-learning goals [8][9]. Over the past 5 years, numerous studies have been conducted to investigate how students utilize open learning resources. Within academic circles, there is a growing interest in this topic, particularly in exploring the most appropriate technologies that can aid students in gathering and managing information and analyzing content in the most effective manner possible. The selection of suitable technology can improve the learning process, increase efficiency, and provide students with information that is relevant and applicable in real-life situations [10]. However, the significant challenge lies in the vast quantity of open learning resources available, and existing systems are unable to effectively collate knowledge from disparate sources to meet the unique requirements of individual learners. Learners are tasked with sifting through information to identify the most reliable sources, some of which may contain outdated information. With current systems, it is difficult for learners to easily and conveniently save and categorize the sources of information they have found for future reference. Learners need the convenience of accessing a variety of knowledge sources, as well as organizing and analyzing the information on their own, which can create challenges in the learning process [11][12]. The objectives of this study is to develop and study the efficacy of a smart resource management system for learning that has the ability to retrieve specific digital information from the internet and social media. This system is equipped with technology that supports self-directed learning via automated digital media. It is a contemporary learning approach that employs the principles of search engines, big data, and artificial intelligence to efficiently locate desired information from reliable sources. This system simplifies the process of independent learning, enabling learners to easily store and share information. It is particularly suitable for self-directed learning and promotes lifelong learning by catering to the diverse needs of learners and facilitating unlimited learning opportunities in the future.

2 Review of literature

The COVID-19 pandemic has highlighted the need for tele-education to respond to sudden and unexpected learning situations. Through various digital platforms and devices, learners can access educational resources anytime and anywhere, promoting lifelong learning [13] as a part of sustainable development. Sustainable development is a crucial aspect of learning, educational resources, and the community, hence the integration of learning provides equal opportunities for everyone in the community to access flexible learning sources that meet their needs and circumstances. Furthermore, private and relevant sectors play a vital role in ensuring that all learners have equal access to continuous sustainable development, which enhances the quality and standard of education at all levels [14][15]. The continuous evolution of learning is in response to learners' current behavior and access to resources [16]. Organizations have recog-

nized and prioritized human resources that possess information technology and communication skills to achieve digital literacy [17]. The continual development of information technology worldwide has generated vast amounts of digital data from various sources. Consequently, a range of advanced technological systems have been created that has substantial storage capacity and can process data using various techniques. This technology allows organizations to search for information and leverage it to enhance their value. Moreover, rapid global changes, including political, economic, social, and lifestyle transformations, coupled with technological advancements, require educators to continually update their curricula and subject matter in educational courses. Both students and educators must also reskill and acquire new skills to succeed in the 21st century. To address the issue of searching for information from different sources, a smart learning resource system management has been developed to cater to users' needs. With this system, learners can independently organize, manage, and analyze relevant information by using various resources effectively. This research aims to develop a smart learning resource management system that utilizes data management technology, supporting mixed-methods self-learning. The research is based on three core concepts, namely big data, machine learning, and search engine optimization.

Big data: the ongoing advancements in information technology worldwide have led to the generation of massive amounts of digital data from various sources. As a result, a wide array of sophisticated technological systems with immense storage capabilities and diverse data processing methods have emerged [18][19]. These technologies enable information retrieval and utilization, ultimately adding value to organizations. Big data is not limited to large-scale data sets; it can also be applied to learner-generated data during interactions with course materials. This data accumulates throughout the learning journey via learning management systems (LMS), content management systems (CMS), and digital media. Additionally, big data concepts can be employed to analyze social media networks, as learner interactions with these platforms offer insights for e-learning organizations or experts to identify potential issues with specific e-learning strategies or tailor content delivery [20][21].By leveraging big data in the development of e-learning systems, experts can gain a better understanding of learners' information processing and identify the learning styles and motivational factors that effectively engage and sustain their attention [22][23].

Machine learning: today, the internet has advanced to a point where vast amounts of data and media are readily accessible, primarily stored in digital formats. This abundance of information enables the study of human behavior by analyzing data to uncover hidden relationships, such as trends and patterns [24][25][26][27]. These insights can be used to develop novel solutions to various problems or to inform decision-making processes. Search engines, web browsers, and other software often utilize machine learning, a field that aims to replicate human intelligence and abilities in computer systems through algorithms, codes, and commands [28][29]. When successful, a machine can carry out tasks using algorithms provided by humans while also evolving and progressing independently. Machine learning is dependent on the data input by humans, often yielding valuable outputs in various forms that can be utilized effectively. The advantages of machine learning rely on the structure of computer programs, with the end goal being a user-friendly, versatile, and highly accurate product [30][31].Practical

applications of machine learning include searching, categorizing, distinguishing, and summarizing data, making predictions based on data analysis, calculating the likelihood of specific outcomes, automating adjustments to rectify or enhance conditions or developments, and optimizing processes according to recognized or remembered patterns.

Search engine optimization: while browsing the internet, most individuals rely on search engines like Google, Yahoo, or Bing as their initial step to discover websites related to their interests, whether they are seeking answers to questions, shopping, catching up on current events, finding solutions to problems, planning vacations, locating good eateries, or pursuing various other objectives [32][33]. When a website appears near the top of the search results for a specific keyword, it has a higher probability of attracting more visitors, gaining popularity, and becoming well-known [34]. Advancements in ICT play a crucial role in transforming traditional learning structures and approaches. Education has shifted from conventional face-to-face classroom methods to online learning facilitated by the internet, overcoming previous limitations such as time, distance, location, and learner capacity. E-learning is a key strategy that has enabled the creation of an online Lifelong Learning Space. The demand for internet-based educational resources is now substantial. E-learning allows information and knowledge assets to be utilized to their fullest potential. Standardized modern technology across platforms can minimize redundancies and streamline the process of searching for and sharing information. This enables faster and more convenient information services, delivering precise information to users in a short period. Undoubtedly, this function greatly supports research and the development of databases and other IT systems, which in turn serve as a robust foundation for educational growth.

3 Research methodology

The objective of this research is to develop the Smart learning resource management system, STOU SmartLearnX, through an analysis of relevant literature, research, and expert interviews. Findings from these analyses and interviews will inform the development of STOU SmartLearnX, which will be validated by a qualified professional. The system will be tested on 65 undergraduate students from three open universities in Thailand, representing three fields of study: Humanities and Social Sciences, Science and Technology, and Health Sciences. A voluntary sampling method is employed for research. To evaluate the system's effectiveness, online nano-learning will be used both before and after implementing STOU SmartLearnX.

3.1 Development of the smart learning resource management system

In initiating the development of STOU SmartLearnX, the researcher began by examining, evaluating, and integrating relevant concepts, theories, research findings, and literature related to learning resource management systems, big data, search engine optimization, and machine learning, and consulted experts in these fields. Subsequently, the STOU SmartLearnX structure was designed based on a conceptual framework focused on optimizing user experience for both learners and educators in the digital era.

Today's consumers have grown up with rapidly evolving technology, making digital interaction a fundamental part of their daily lives. Utilizing technology for learning, information searching, knowledge sharing, and exchanging experiences comes naturally to them. Online digital data holds significant value for modern users, and contemporary technology has facilitated the bridging of educational gaps, allowing anyone to learn, share, and teach through disseminating diverse information online. The smart learning resource management system developed caters to the diverse and ever-changing behaviors of end-users. It addresses the needs of digital-age learners who prefer "nanolearning," a tailored, individualized approach that provides precise and concise information in short bursts. STOU SmartLearnX enables learners to easily locate specific knowledge, and systematically store and manage their learning. This method is more efficient than traditional, lengthy classroom sessions. Designed to be flexible, sleek, and easy to understand, STOU SmartLearnX employs widely accepted icons and allows users to search for, store, and share information systematically. It features a user-friendly bookmark system that showcases page samples on the home screen, enabling bookmark management similar to a mini online course. The system consists of five primary components, as illustrated in Figure 1 and Figure 2.

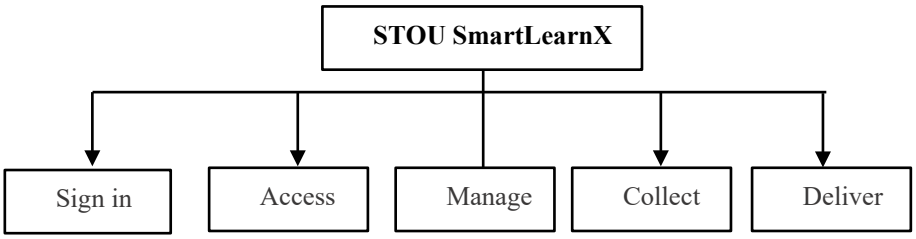

Fig. 1. Structure of STOU SmartLearnX

Sign in. the versatile multi-platform system is compatible with an array of devices, encompassing various smartphone brands and other mobile computing devices. Users can access information regardless of their location, provided they have an internet connection. The system is user-friendly, allowing individuals to log in from multiple devices using the same username or user ID, including via their Facebook or Gmail accounts. Additionally, a built-in user guide enables users to independently find solutions to any questions they may have regarding system usage.

Access. the platform enables students to acquire additional knowledge by directing them to specific topics of interest and recommending related materials. Users can specify the kind of information or media they prefer, such as websites, pictures, or videos. Immediately, they can view examples on the main page without incurring any charges.

Manage. the system presents and organizes data in a unified content layout, offering a streamlined "one page" learning experience. Users have the option to explore any section of the material more deeply. The system selectively displays trustworthy content, filtering out any unreliable data. Users can create a personalized knowledge repository by methodically categorizing and storing their preferred search outcomes.

Collect. users can save desired content into various categories, allowing for convenient access to saved items in their personal account at a later time. The information saved can be located on the homepage, ensuring the user's security is consistently maintained. Additionally, each user can effortlessly modify or update their personally saved files as needed.

Deliver. users can disseminate content and knowledge, allowing others to benefit from well-structured open learning resources. Information can be shared across various platforms via links, social media, or email to foster a collaborative learning experience.

Subsequently, the research introduced the STOU SmartLearnX smart learning resource management system to a panel of 15 experts in learning environment design, educational technology, and lifelong education for quality assessment. Based on the experts' recommendations, the system was revised before being tested with a group of undergraduate students at an open university in Thailand.

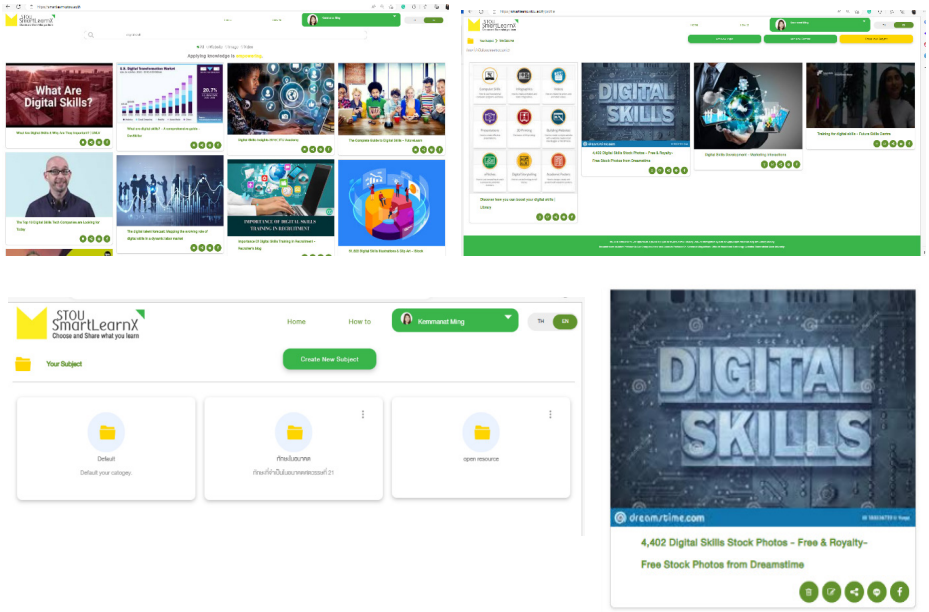

Fig. 2. Examples of STOU SmartLearnX online learning management system

3.2 Research sample

The test group for STOU SmartLearnX included 65 undergraduate students from Sukhothai Thammathirat Open University, who participated voluntarily. The participants were divided into three categories: 21 students from Humanities and Social Science, 21 from Science and Technology, and 23 from Health Science, totalling 65 students.

3.3 Research instruments

The study utilized the STOU SmartLearnX program as a research tool, which was evaluated by a panel of 15 specialists in learning environment design, educational technology, and lifelong education. They rated it as having top-tier quality (M = 4.60, SD = 0.61). Additionally, a 15-question pretest and 15-question posttest were used in the study. These questions were assessed by experts and found to have a difficulty index ranging from .33 to .75, a discrimination index ranging from .24 to .79, and a reliability score of .86 based on the Kuder-Richardson 20 formula.

3.4 Research method

The study conducted a preliminary assessment of the STOU SmartLearnX system for managing smart learning resources through a pre-experimental approach. The research was structured as a single-group pretest and posttest design, with the objective of delivering an online course centered on Nanolearning, which involves short learning sessions enabling learners to acquire knowledge without feeling overwhelmed by lengthy classroom sessions. The learning tools employed are tailored to the course content, facilitating better understanding and improved learning outcomes compared to traditional classroom instruction, as demonstrated in Figure 3.

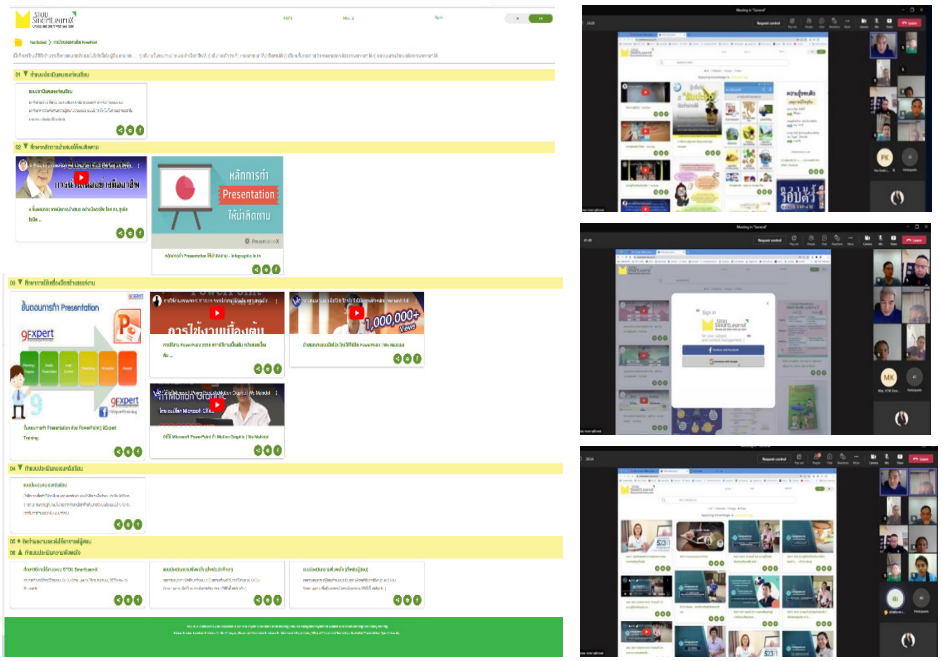

Fig. 3. Examples from the trial run of STOU SmartLearn X

The researcher gave guidance to students on how to utilize a smart management system for learning resources through Microsoft Teams. Afterwards, the researcher conducted online learning activities with a focus on Nanolearning. Prior to the commencement of the experiment, the students in the study group took a pretest, and a posttest was administered after the trial concluded.

3.5 Data analysis

The samples' pretest and posttest scores were compared by t-test dependent one-way ANOVA.

4 Research findings

After employing the STOU SmartLearnX smart learning resource management system in a trial run, the average scores of the participants in the post-test increased significantly, with a mean of M= 10.92 and SD= 1.89, which was considerably higher than the mean pre-test score of M= 5.42 and SD= 1.88, with a statistically significant difference at .05. The results indicated that students in Humanities and Social Science, Science and Technology, and Health Science all exhibited a statistically significant increase in their mean post-test scores when compared to their pre-test scores, as shown in Table 1.

Table 1. Comparison of pretest and posttest scores divided by group of study

Group	Time	N	M	SD.	t	p
Humanities and Social science	pretest	21	4.81	1.50	11.25-	00.
	posttest	21	10.52	1.69		
Science and Technology	pretest	21	6.29	1.79	10.49-	00.
	posttest	21	11.62	1.60		
Group	**Time**	**N**	**M**	**SD.**	**t**	**p**
Heath Science	pretest	23	5.17	2.04	8.81-	00.
	posttest	23	10.65	2.19		
Overall	pretest	65	5.42	1.88	17.45-	00.
	posttest	65	10.92	1.89		

Table 2 illustrates the outcomes of the trial employing the STOU SmartLearnX smart learning resource management system, where the mean posttest scores for Humanities and Social Science samples were 10.52 (*SD.*1.69), while for Science and Technology samples it was 11.62 (*SD.*1.60), and for Health Science samples, it was 10.65 (*SD.* 2.19). Notably, no significant statistical variation was detected in the mean posttest scores across the three groups. Therefore, the study suggests that this smart learning resource management system can be effectively implemented for students pursuing diverse areas of study.

Table 2. Posttest scores divided by school of study

Group	N	M	SD.	F	p
Humanities and Social science	21	10.52	1.69	2.21	.118
Science and Technology	21	11.62	1.60		
Health Science	23	10.65	2.19		

5 Discussion

The results of the trial run of the STOU SmartLearnX smart learning resource management system indicated that there were no significant differences among the three student groups (Humanities and Social Science, Science and Technology, and Health Science) in terms of their familiarity with accessing information through various digital platforms. The STOU SmartLearnX system was created to cater to the unique needs of users, thereby reducing the limitations of separate learning resources. The system employs blended learning resources that are integrated with technology to analyze needs and recommend faster and more convenient digital resources, such as websites, pictures, videos, etc. Students can store interesting information and access learning resources in the same way. As noted in [35], the emergence of new technology has led to an expansion of available learning sources. New intelligent technology has been developed to create tools and techniques that can be used by everyone, making education more comprehensive. Learners can now use tools to find specific content that they need [36][37], which is advantageous for educators, who can design and develop more flexible curricula and educational content that meet the needs of individual learners [38]. If a learning resource management system has prompts and suggestions to help users find relevant information, it can aid them in the decision-making process by filtering information and providing diverse options [34]. Automated smart systems are becoming more prevalent and efficient in suggesting learning resources to learners [39].

6 Conclusion

The purpose of this investigation was to develop and study an intelligent learning resource management system known as STOU SmartLearnX, which can be used for self-directed learning. The preliminary examination of the system on undergraduate students found no significant difference in learning outcomes across three distinct academic fields. The average post-test scores of all three groups were higher than their pretest scores, indicating that they all achieved satisfactory learning outcomes. Based on these findings, we conclude that STOU SmartLearnX is an easy-to-use tool that can assist learners in accessing information and organizing their studies, making it ideal for individuals who enjoy seeking out information and wish to learn at their convenience. STOU SmartLearnX offers an effective learning experience that stimulates learning by allowing learners to utilize learning resources at their convenience. This research represented the initial development of the system, which provided the necessary tools for users to access learning resources. The information displayed depends on the system's

search capacity. In the future, the system may be improved by utilizing advanced search methods and images to provide more precise results that consider the context and respond accordingly. An automatic system or chatbot could be integrated to provide personalized advice tailored to the user's needs.

7 Conflict of interest and research ethics

The authors declare no conflict of interest. Research ethics, this research is allowed to conduct research according to the announcement of Bansomdejchaopraya Rajabhat University: No. BRSU-REC 6406001 on June 4, 2021.

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