EDUTECH

Jurnal Teknologi Pendidikan

Journal homepage https://ejournal.upi.edu/index.php/edutech

The Importance of LMS to Improve Data Science Learning Performance

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ABSTRACT

The increasing demand for talent with Artificial Intelligence competencies in recent years has driven the growth of various non-formal educational institutions in Indonesia. These include training programs, bootcamps, short courses, and eLearning formats—ranging from fully online or offline learning to distance and blended learning models. These programs are typically offered at more affordable prices and with shorter learning durations. Making them attractive to both fresh graduates and professionals seeking to switch careers into the field of Data Science. This has contributed to greater diversity within the Data Science learning ecosystem.

The learning in these non-formal education institutions are usually trainer-centered instruction. The materials of these trainings are delivered with examples. At the end of the training period, participants are assigned a capstone project to examine their understanding of materials.

Although pedagogical methods are commonly used, they often fail to address the specific learning needs of adult learners. Leading to cognitive overload, low engagement, and suboptimal learning outcomes. This study explores the role of Learning Management Systems (LMS) and andragogical approaches to improve data science learning outcome. Drawing on literature reviews and empirical findings, this paper argues that integrating LMS with andragogical approaches can significantly enhance the effectiveness of non-formal Data Science education, particularly in addressing Indonesia's digital talent gap.

ARTICLE INFO

Article History:
Submitted/Received 5 Juni 2025
First Revised 19 Juni 2025
Accepted 28 Juni 2025
First Available online 01 Okt 2025
Publication Date 01 Okt 2025

Keyword:
Data Science, Artificial Intelligence, andragogy, Learning Management System, distance learning.

1. INTRODUCTION

Artificial Intelligence is a technology that replicates human intelligence into machine systems for specific functions. Through this technology, machines or programs are able to perform various tasks more effectively and efficiently. In many cases, this technology surpasses human capabilities by minimizing or eliminating the risk of human error.

This advancement has triggered a rapid increase in demand for talents with technical competencies in Artificial Intelligence. Talents such as Data Scientists, Data Analyst, AI Engineers, Computer Vision Engineers, and similar professions become highly favored positions. As a consequence, formal education institutions have established relevant study programs, ranging from general fields like Computer Science to specialized ones such as Bioinformatics and Computational Biology.

At the same time, the urgency for businesses to adopt this technology as quickly as possible cannot be fully supported by formal education graduates. Formal education often takes longer to produce graduates, which creates a mismatch with rapidly evolving industry demand in the Data Science field. This situation has driven the emergence of non-formal educational institutions. Non-formal education institutions which offer short courses, training programs, bootcamps, and e-learning through in-class learning, distance learning, fully online learning, and blended learning formats. These programs attract not only university students or fresh graduates, but also career switchers and working professionals who are required to upgrade their skills.

Generally, the learning is delivered with a pedagogical approach and trainer-centered method. Where the instructor presents the materials, followed by examples and structured exercises to reinforce participants' understanding. The training typically concluded with a capstone project, for the participants to apply the acquired knowledge. In e-learning or short courses format, the instruction may only consist of independent practice assignments to be completed.

However, this approach is less suitable for adult learners. Trainers and teams often fail to observe participant's entry behaviors which influence their ability to grasp materials effectively. Entry behaviors refers to prior knowledge, skills, and attitude. In adult learners, experience plays a significant role in shaping how the learner engages with learning activity. As result, participants may become demotivated early in the learning process. Participants may also experience cognitive overload due to the demand to understand many things simultaneously without the right learning strategies.

Distance and online learning have made use of learning resource management platforms known as Learning Management Systems (LMS). However, the use of LMS in various learning methods—including online, distance, blended, or even full in-class learning—has not been fully optimized. LMS is mostly recognized for its course management features, where instructors or course managers simply upload learning resources and quizzes. In reality, the LMS platform also offers features which enable effective indirect learning strategies for adult learners. As independent and self-driven learners, adults seek learning experiences that are relevant to their needs and applicable to their personal and professional context.

This study aims to explore the role of Learning Management Systems (LMS) and andragogical approaches to improve data science learning outcome. It is a literature-based study that entirely uses secondary data.

2. METHODS

This study employs a literature review approach using a meta-analysis method. The study began with the identification of key issues commonly encountered by participants in training, bootcamps, or similar programs in the field of Data Science. This issue was formulated as a research question. Relevant literature was systematically searched using keywords such as "Data Science," "Computer Science," "Andragogy," "LMS," "Online Learning," and

DOI: https://doi.org/10.17509/e.v24i3.86518
P-ISSN 0852-1190 E-ISSN 2502-0781

"Distance Learning". Finally a systematic review was then conducted, resulting in 15 journals being selected based on pre-defined inclusion criteria. These journals were further filtered based on their relevance to the research theme. The priority given to literature published within the past five years, which were sorted in descending order by publication year.

The preferred literatures are literature which explore trends in Data Science, transformational learning using Learning Management system, andragogical learning approaches which can enhance adult learning performance. Data used in this study are analyzed and summarized to answer the key research question : how does the role of Learning Management Systems and andragogical approach improve data science learning outcome?

3. LITERATURE REVIEW

Belloum et al. (2019), observed that the surge in demand for Data Science professionals has resulted in the increase of training programs, courses, books, and formal education initiatives across undergraduate, master's, and doctoral levels. As a consequence, there is a lack of standardized definitions and competencies for this profession and its related roles. Within the education domain, the proliferation of terminologies and significant differences in required skill sets raise challenges for trainers and educators in designing appropriate learning programs.

In non-formal education settings, participants are expected to master Data Science or specialized subjects like Data Analytics within a short period (1–3 months). They are typically taught basic knowledge, including programming, followed by assignments and projects. However, such pedagogical approaches may cause cognitive overload (Sweller, 1988).

Learners who are required to learn the provided examples independently may achieve better outcomes than those who are exposed to problem-solving approaches which are commonly used in pedagogy (Kirschner, Sweller et al., 2006). Example-based learning has proven to be more efficient (Sweller and Cooper, 1985), while practicing exercises can stimulate self-explanation skills—encouraging learners to articulate their understanding (Bielaczyc, Pirolli et al., 1995).

According to Kaddoura and Al Husseiny, traditional teacher-based classroom learning methods in higher education have already become outdated. There has been a notable shift from teacher-centered to student-centered learning, aiming to develop active learners. For this, a new framework to enhance competencies and performance is needed.

Malcolm Knowles identifies five criterias for adult learning: self-concept, learners' experience, readiness to learn, learning orientation, and internal motivation. Self-concept refers to adult learners being self-directed and independent. Experience suggests that prior learning shapes their perception of new topics, so varied approaches are needed to uncover those experiences. Readiness indicates that learners link the material with real-life applications. Learning orientation focuses on practical applications, while internal motivation includes the need of every learner to acquire new skills or gain self-esteem.

In their model for online learning, Kaddoura and Al Husseiny found that 71.4% of participants strongly agreed, and 19% agreed, that learning motivation is significantly influenced by Information and Communication Technology tools. Furthermore, 90.4% believed that ICT tools can enhance motivation. The same questionnaire revealed that ICT tools also improve learners' critical thinking, with 93% giving a positive response (64.3% strongly agreed and 28.6% agreed).

Basically, Learning Management System is a platform for instructors to design, develop, and prepare online classrooms (Walker, 2006). Over time, LMS has evolved to support connections and integrations between instructors and learners through online knowledge-sharing environments. This enhances engagement—a crucial element in learning (Schoonenboom, 2014). LMS allows stakeholders (faculty and adult learners) to communicate,

DOI: https://doi.org/10.17509/e.v24i3.86518
P-ISSN 0852-1190 E-ISSN 2502-0781

interact, and engage in a transformative teaching model, especially in online settings (Reid, 2019). Through LMS websites, instructors and learners can post learning resources, quizzes, exercises, and comprehensive exams (Reid, 2019).

Research has also been conducted on faculty perspectives regarding LMS utilization to manage learning activities, improve student engagement, and track performance. Findings show a positive correlation between faculty attitudes and LMS usage in online classrooms (DeNeui & Dodge, 2006). Student satisfaction with LMS is associated with course content, usefulness, stakeholder communication, knowledge transfer, past achievement, and computer literacy (Reid, 2019). LMS is also believed to enhance human intelligence and expand learners' perspectives regarding the significance of knowledge and its future applications—especially within their field of study (Reid, 2019).

((there is a research which emphasize how LMS and andragogical approach increase student's ability to grasp the materials))

4. RESULTS AND DISCUSSION

Artificial Intelligence (AI) has experienced significant advancements in recent years. As the name suggests, "artificial" refers to something man-made, while "intelligence" denotes cognitive abilities. Artificial Intelligence mimics human capabilities and is implemented into machines or programs. Whether performing simple tasks like basic arithmetic to complex functions such as face recognition.

In parallel with AI, the concept of Data Science has also gained traction. Broadly speaking, it involves processing data using scientific methods to extract patterns and generate insights. These insights empower decision-making processes, enable task automation, and offer various other benefits. Data Science applications in everyday life include product recommendations on e-commerce platforms, determining pricing and trip durations in ride-hailing apps. While both AI and Data Science are related, AI has a broader scope, aiming to simulate human cognition such as learning, reasoning, and problem-solving.

According to a 2019 report by the World Bank, Indonesia is projected to face a shortage of approximately 9 million technology professionals between 2015 and 2030. The majority of unmet demand occurs in data-related roles. This talent gap is challenging to be addressed solely through formal educational institutions such as universities and polytechnics. In Indonesia, the development of data talent has only recently begun to receive significant attention—coinciding with a surge of demand in industry for such talent.

This phenomenon presents opportunities for non-formal education providers—such as Pacmann, DQLab, Algoritma, IYKRA, and others—to offer training, bootcamps, and short courses in general or specialized Data Science topics (e.g., financial data analysis, fraud analytics, HR analytics). These programs offer shorter durations and more affordable pricing compared to formal education, therefore attracting fresh graduates and career switchers from non-linear backgrounds. This diversity adds to the complexity of learners' backgrounds, needs, and learning outcomes.

Belloum et al. (2019) conducted a study which involved over 300 educational programs, more than 100 courses in academia and industry, and around 1000 job listings. This study found that the exponential increase in demand for Data Scientists has not only expanded opportunities for both formal and non-formal educational institutions, but also added to the complexity of defining the field itself. There is no standardized definition of Data Science, and the required skill sets and competencies vary widely. As a result, three main challenges have emerged :

1. Learners struggle to identify the most suitable educational programs
2. HR professionals face difficulties in recruiting and evaluating the right candidates
3. Educators face challenges in designing effective learning programs tailored for Data Scientist or Data Science research career paths.

DOI: https://doi.org/10.17509/e.v24i3.86518
P-ISSN 0852-1190 E-ISSN 2502-0781

Moreover, the prevalent pedagogical approach used in most programs—centered around the teacher or trainer—raises issues for adult learners. This approach typically includes materials delivery, followed by examples and exercises, and concludes with a capstone project using real-world or simulated use cases. The concise time frame often forces learners to grasp fundamental concepts and apply them simultaneously, leading to cognitive overload and a lack of deep understanding.

For adult learners such as fresh graduates and career switchers, this pedagogical approach may lead to various issues which lead to ineffective learning. Moreover for non-technical backgrounds, such methods will result in difficulty to understand materials, lack of motivation and engagement, and ultimately unsatisfactory learning outcomes—especially for those from non-technical backgrounds.

To address these challenges, Malcolm Knowles proposed the andragogical approach tailored to adult learning. Knowles outlines five assumptions about adult learners:

1. Self-concept : Adult learners are self-directed and independent.
2. Experience : They bring prior knowledge and life experience.
3. Readiness to learn : They are driven to learn things relevant to real-life applications.
4. Orientation to learning : Their learning is goal-oriented and task-centered.
5. Motivation to learn : Motivation is often intrinsic, driven by the desire for new skills or personal growth.

The difference between pedagogical and andragogical learners detailed as below :

Table 1. Andragogy vs Pedagogy

Andragogical principles	Pedagogy	Andragogy
The need to know	Learners do not need to know what and why they need to learn	Learners want to know what and why they need to learn
Learner's self-perception	Dependent personality	Self-directedness
Role of experience	Experiences play little role	The role of experiences is a rich resource for learning
Readiness to learn	Learners are ready to learn what they have to learn	Learners are ready to learn what they need to learn
Orientation towards learning	Subject-oriented	Life/task/problem-oriented
Motivation to learn	External motivations (parental pressure, teacher's approval or rejection, grades)	Internal motivations (job satisfaction, self-confidence, self-esteem, quality of life)

Adults are self-directed learners, motivated by their prior experiences and real-life needs. They learn most effectively when they are able to control their own learning processes and take responsibility for it. Therefore, incorporating flexibility within the learning process is essential for effectively supporting adult learning. In this context, Learning Management Systems (LMS) can serve as a valuable platform to facilitate flexible, learner-centered experiences for adults.

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P-ISSN 0852-1190 E-ISSN 2502-0781

A Learning Management System (LMS) is a technological product that facilitates interactions among all learning stakeholders. LMS platforms enable online, knowledge-sharing environments that foster greater engagement—an essential element of effective learning (Schoonenboom, 2014). Generally, LMS platforms offer features such as :

Table 2. Features of LMS

Features	Description
Course management	Allows trainers or administrators to create, organize, deliver, and maintain learning materials.
Assignments	Enables trainers to assign exercises with specific deadlines.
Forums	Facilitates discussions, Q&A, workshops, and announcements.
Chats	Enables peer and trainer communication.
Quizzes	Includes assessments like multiple choice, true/false, essays, or short answers, with grading features.
Blogs & Wikis	Supports collaborative environments for both instructors and learners
Glossary	Offers a dictionary for subject-specific terminology.
RSS Feeds	Integrates external news updates into the platform.
Analytics	Transforms platform activity logs into actionable insights for learners, instructors, and administrators.
User Management	Manages user roles and access levels

A survey conducted by Sanusi, Md. Nurazlina et al. (2019) to 54 computer science students of Universiti Teknikal Malaysia Melaka (UTeM) for two semesters. The survey examines student learning preferences and engagement in blended learning using LMS. The survey found that 62% of students wanted their assignment to be relevant to real-life problems with the use of learning support tools. They also wanted the assignments to be clearly explained by the lecturers. There were 50% of students who wanted assessment methods to be clearly spelt out. For student engagement survey items, found that 62% of students were more engaged when provided with detailed assignment guidelines. 47% of students responded that they are engaged in learning when asked about doing pair work, 45% voted for detailed feedback from the lecturers.

The survey responses are encoded and classified, concluding that LMS fosters various factors contributing to the students' engagement. Factors like promoting interest in learning, personal thought, organizing study better, promoting answering skills,promoting communications,promoting better understanding,system flexibility,promoting higher order thinking skills,and prompt feedback.

5. CONCLUSION

The rapidly evolving demands of industry have driven the emergence of non-formal educational institutions to address skill gaps in the workforce. However, these institutions often employ ineffective learning strategies, relying on traditional pedagogical approaches where the delivery of material is centered on the trainer’s knowledge, while learners passively follow.

DOI: https://doi.org/10.17509/e.v24i3.86518
P-ISSN 0852-1190 E-ISSN 2502-0781

Such approaches do not provide adult learners with the autonomy to determine what they need to learn or how they prefer to learn it.

In this context, Learning Management Systems (LMS) offers features which facilitate andragogical approach learning. Like course management which enables material delivery any time anywhere, forums which support collaboration and discussion, assignments functions to assess learners' understanding, chat features that enable direct communication between peers and with instructors, analytical dashboard that enable educators to monitor learning performance and make necessary decisions on it. Several studies found that the use of LMS enhances learning experiences and increases student engagements.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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P-ISSN 0852-1190 E-ISSN 2502-0781