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Digital Transformation in Education: Multidimensional Effects of Artificial Intelligence Supported Learning Management Systems

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The aim of this study is digital transformation in education: multidimensional effects of artificial intelligence supported learning management systems. The impact of artificial intelligence applications in education has been examined through four basic dimensions. These are (1) student performance, (2) teacher adaptation, (3) educational materials and methods, and (4) measurement and evaluation. Among the qualitative research methods, the phenomenological approach was preferred. The phenomenon of this study is the use of artificial intelligence applications in education in the context of digital transformation. This phenomenon covers especially the integration of artificial intelligence supported learning management systems (LMS) into educational processes and the effects of this integration on digital transformation. The study group consists of students, teachers, administrators and educational technology experts at a private school using an artificial intelligence-based learning platform. To examine the impact of digital transformation in education, detailed data was collected by collecting data from different target audiences. The data obtained through observations and interviews were presented by content analysis. As a result of the study, systemically supportive reflections on students' academic performance, supportive reflections and negative reflections in terms of the learning process; reflections on the learning process regarding teacher adaptation and adaptation in the transformation process in education; In terms of teachers and students regarding the impact of educational materials and teaching methods; Regarding the measurement and evaluation processes, themes of reflections on the measurement and evaluation processes were created.

Introduction

The term artificial intelligence was first discussed in a proposal letter presented by John McCarthy, Marvin L. Minsky, Nathaniel Rochester and Claude E. Shannon in 1956 at the Dortmund Conference (Alpaydın, 2013). Artificial intelligence (AI) is the technology that focuses on doing everything that can be done with human intelligence through computer technologies. In other words, artificial intelligence is the artificial reintroduction of the

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competencies that are found in the individual (Aydın & Değirmenci, 2018). Artificial intelligence refers to the field of computer science that focuses on creating intelligent machines capable of performing tasks that typically require human intelligence (Shoka et al., 2023). These tasks can include learning, problem-solving, perception, language understanding, and decision-making (Gao & Wang, 2023). Artificial intelligence is a branch of computer science that involves the development of intelligent machines capable of performing tasks that typically require human intelligence (Kak, 2021). By leveraging advanced algorithms and large amounts of data, artificial intelligence enables these machines to learn from experience, adapt to new situations, and improve their performance over time (Aljaloud et al., 2022). According to Arslan (2020), artificial intelligence is the ability of computers to display individual-specific behaviors such as reasoning, problem solving, generalization and prediction, in other words, the ability to use high-level cognitive skills. Artificial intelligence is a computer science that enables machines to gain the ability to learn. This technology measures the ability to achieve previously set goals (Frank et al., 2019). This technology, which is used in many fields today, is also widely used in the field of education. Therefore, it is known that the field of education is an important field affected by artificial intelligence technology.

Considering a generation that is intertwined with technology in the 21st century and has been introduced to information and communication technologies since the moment they were born, it is evident that education should go beyond traditional teaching methods (Kış, 2019). For this reason, one of the biggest problems encountered in the education system is that learners learn in different ways or at different levels (Sarıbaş & Babadağ, 2015). Learners have different levels of learning skills and various interests. However, generally uniform learning-teaching methods found in schools are used (Boydak, 2015). One of the technologies that helps solving this problem is artificial intelligence. International conferences have been organized by the International Society for Artificial Intelligence in Education (IAIED) since 1997 to discuss how artificial intelligence technology can be used in the field of education, about its contributions to teachers and learners, its risks and problems to be encountered. In addition, the International Journal of Artificial Intelligence in Education is also published regularly (Knox et al., 2019). Artificial intelligence studies in the field of education have increased in recent years (Akdeniz & Özdinç, 2021). Turkish Ministry of National Education (MEB)'s objectives for 2023 include the use of artificial intelligence applications to improve learning-teaching processes in the field of education (MEB, 2023).

It is known that artificial intelligence technology enables learners to access the information they need more efficiently and supports learning at their own pace. Moreover, some artificial intelligence applications allow the learner to work at any time period. In line with this opportunity, it is evident that learners benefit from learning outcomes at maximum level as soon as their motivation for learning increases. In addition, it has been observed that learners create a more effective instructional design with their learning interactions and learning experiences through artificial intelligence technologies (Popenici & Kerr, 2017; Kharei et al., 2018). Among the advantages of artificial intelligence concerning education applications is that it provides very fast and low-cost observations and procedures (Zeide, 2019). In addition to these, the benefits of artificial intelligence in education are as follows (Erdurmuş, 2023, Karsenti, 2019; Karsenti, Bugmann, & Gros, 2017; Karsenti et al., 2019; Sağdıç & Sani-Bozkurt, 2020):

(1) It can be adapted to the learner's problem and can provide various solutions accordingly.

(2) It creates learner-centered learning environments.
(3) It can be stated that learning environments supported by artificial intelligence technology increase academic success.
(4) Education policies can be updated according to data collected from various educational institutions that provide education through artificial intelligence.
(5) It offers a collaborative learning environment.
(6) It reduces the teacher's workload because artificial intelligence technology prepares the teaching materials required in the learning-teaching process instead of the teacher.
(7) It can provide support to individuals with special needs throughout the learning process.
(8) It can be advantageous in crowded learning environments.
(9) It provides consistent and instant feedback.
(10) Voice communication can be provided between the learner and the content.
(11) It can provide learning environment that is virtual reality.

One of the areas where all these items are used in education is artificial intelligence supported learning management systems. These artificial intelligence-supported learning management systems have the potential to greatly enhance the learning experience for students by tailoring instruction and recommendations according to their individual needs, goals, and preferences. The use of artificial intelligence in learning management systems can lead to more personalized and adaptive learning experiences for students. Furthermore, artificial intelligence-supported learning management systems can also provide intelligent assessment and evaluation of students' performance. This can improve the efficiency and effectiveness of assessments, as artificial intelligence can analyse and provide feedback on student work in a more timely and accurate manner. Overall, the integration of artificial intelligence into learning management systems can have several effects. Firstly, it can improve the safety and fairness of artificial intelligence-driven decisions by providing transparent explanations for those decisions. Secondly, it can enhance the personalization and adaptability of learning experiences, allowing students to learn at their own pace and in line with their specific learning needs. Lastly, artificial intelligence-supported Learning Management Systems can contribute to the development of efficient and effective learning systems. These systems can provide personalized learning support based on students' preferences, learning status, and the characteristics of the learning content and environments (Mohseni et al., 2018). In addition, artificial intelligence-supported learning management systems can also engage students in higher order and meaningful thinking through the use of mind tools. By leveraging artificial intelligence, these systems can provide personalized recommendations, adapt the learning content to individual students' needs, and create a more engaging and interactive learning environment (Sottilare et al., 2019). Artificial intelligence-supported learning management systems have been found to improve student engagement, motivation, and overall achievement. These systems have the capability to analyze vast amounts of data, identify patterns in student performance, and provide targeted interventions and resources. Additionally, artificial intelligence-supported learning management systems can offer personalized recommendations for students, such as suggesting additional resources or practice exercises based on their individual strengths and weaknesses. This personalized approach to learning has been shown to result in improved academic outcomes for students. the impact of artificial intelligence-supported learning management systems on student academic performance is seen as positive, with the potential to revolutionize the way students learn and succeed in educational settings. (Dong, 2023).

Artificial intelligence-supported learning management systems have the potential to greatly

impact not only student but also teacher adaptation. Artificial intelligence-powered assessment tools can help teachers evaluate student performance more efficiently and effectively. This can free up valuable time for teachers, allowing them to focus on areas that require more personal attention and support. Additionally, the use of artificial intelligence in learning management systems can provide valuable insights and analytics to teachers, allowing them to track student progress and identify areas of improvement. Overall, the integration of artificial intelligence in learning management systems has the potential to enhance teaching practices and empower teachers to better meet the diverse needs of their students (Mohseni et al., 2018). With the advent of Artificial intelligence-supported learning management systems, educational materials and teaching methods are undergoing a transformation. These systems have the potential to provide personalized learning experiences for students, taking into account their individual preferences, learning styles, and progress. Artificial intelligence can assist in the development of educational materials by generating content, providing suggestions for improvement, and adapting materials to meet the specific needs of students. This allows for a more efficient and effective learning experience, as students receive targeted feedback and support in real-time. Additionally, artificial intelligence-supported learning management systems have the potential to enhance student engagement and motivation (Dong, 2023). These systems can leverage artificial intelligence algorithms to collect and analyze vast amounts of data on student performance and engagement, allowing for more accurate and timely assessments. Artificial intelligence-supported learning management systems can automate the process of grading and provide real-time feedback to students, enabling personalized learning experiences. Furthermore, artificial intelligence can also support the development of adaptive assessments that dynamically adjust to a student's skill level and individual needs. The impact of artificial intelligence-supported learning management systems on measurement and evaluation processes is expected to lead to more accurate assessments, personalized feedback, and improved instructional strategies (Prieto et al., 2019).

As a result, academic performance is an important dimension since Artificial intelligence-supported learning management systems provide a personalized learning experience (Holmes et al., 2019). Teacher adaptation is important because the teacher takes an active role in the process of adapting to new technologies and integrating these technologies into teaching processes (Karsenti, 2019). The literature emphasizes that artificial intelligence-supported learning management systems make teaching materials and methods dynamic and interactive (Alpaydın, 2013). Finally, another element of learning processes is measurement and evaluation. The literature states that artificial intelligence-supported learning management systems can make these processes more efficient and effective (Zhai et al., 2021).

When the literature is examined, it is emphasized that the future of education in the field of artificial intelligence, the ethical dimension of the use of artificial intelligence in education, the possibilities and limitations of using artificial intelligence in education, and the positive effects of using artificial intelligence in education (Kavitha et al., 2023; Drach et al., 2023; Nagi et al., 2023; Samar, 2023; Harry, 2023; Tkachenko, 2023; Pedro, et al., 2019; Owoc, et al., 2019, Akgun, & Greenhow, 2022). These studies have revealed various advantages and limitations of AI in education such as personalization, accessibility, ethics, efficiency, and increasing student motivation. Furthermore, Samar (2023) emphasizes the uncertainty among educators about effectively utilizing the pedagogical advantages of AI. Huang (2023) states that there should be guidelines on what to pay attention to in the process of integrating artificial intelligence into education. Pendy (2021) states in his study that more research is needed to understand what the situations experienced in the process of artificial intelligence

applications that transform the education process. Therefore, it is necessary to examine artificial intelligence applications in education in terms of digital transformation in order to understand how these potential benefits can be realized and to address ethical, security and privacy issues in applications. Thus, the education system can be made more fair, efficient and effective. In addition, it is thought that it will be important to look at these dimensions addressed by the existing studies in the literature from a holistic perspective. Based on all these, the aim of this study is digital transformation in education: multidimensional effects of artificial intelligence supported learning management systems. With respect to this purpose, answers were sought to the following sub-research questions:

(1) What is the impact of artificial intelligence-supported learning management systems on student academic performance?
(2) What is the impact of artificial intelligence-supported learning management systems on teacher adaptation?
(3) What is the impact of artificial intelligence-supported learning management systems on educational materials and teaching methods?
(4) What is the impact of artificial intelligence-supported learning management systems on measurement and evaluation processes?

Methodology

This section includes information about the research model, study group, data collection tools, data collection process and analysis.

Research Design

With respect to the purpose of the research, a qualitative research model was preferred in this study. The qualitative research design stems directly from the interaction with the participants. Qualitative research studies are conducted in order to understand individuals' experiences, lives, perceptions, attitudes, feelings and behaviors. For this reason, qualitative research mostly reveals participants' perspectives and experiences through methods such as detailed interviews, observations, focus groups and content analysis (Hart, 1998). Among qualitative research methods, the phenomenological research approach was preferred in this study. Phenomenological research is a research approach carried out to understand and interpret an individual's experiences. The phenomenological approach focuses on people's direct expression and understanding of their experiences (Güçlü, 2019).

Study Group

Although different sampling methods are used in qualitative researches, it is generally necessary to select the sample that can best explain the purpose of the research. Therefore, in qualitative research methods, detailed studies are carried out with appropriate samples for a long time so as to reach detailed results (Baltacı, 2018). For the purpose of this study, criterion sampling was preferred among various sampling methods under purposeful sampling methods. The purposeful sampling method is a type in which the sampling is determined by the researcher by focusing on a purpose or problem. The most important feature of this method is that it includes groups or individuals with certain qualifications to better explain the main purpose of the study (Bryman, 2016). Criterion sampling is referred to the sampling based on certain criteria set by the researcher (Creswell & Creswell, 2017). Within the scope of this study, the criterion is that students, teachers, administrators and

educational technology experts used an artificial intelligence-supported learning management system. Demographic information of the study group is given on Table 1.

Table 1. Demographic information concerning the participants in the study group

Code	Gender	Age	Duty	Educational Status	AI Time of Use
S1	Male	15	Student	Secondary school	2
S2	Male	16	Student	Secondary school	3
S3	Female	14	Student	Secondary school	1
S4	Male	17	Student	Secondary school	3
S5	Male	16	Student	Secondary school	2
S6	Male	15	Student	Secondary school	2
S7	Female	17	Student	Secondary school	3
S8	Female	16	Student	Secondary school	2
S9	Male	16	Student	Secondary school	3
H1	Female	31	Teacher	Primary school	4
H2	Female	35	Teacher	Secondary school	3
H3	Male	36	Teacher	Secondary school	3
H4	Male	32	Teacher	Primary school	2
H5	Male	39	Teacher	Primary school	1
H6	Female	37	Teacher	Secondary school	2
H7	Male	36	Teacher	Secondary school	1
H8	Male	30	Teacher	Primary school	1
H9	Female	38	Teacher	Secondary school	4
H10	Female	32	Teacher	Primary school	2
ET1	Male	32	Educational Technologist	-	4
ET2	Female	34	Educational Technologist	-	4
M1	Male	44	Administrator	Primary school	2
M2	Female	37	Administrator	Secondary school	3
M3	Female	38	Administrator	Secondary school	3

The study group consists of the number of participants in different positions is as follows: 9 students, 10 teachers, 2 educational technologists and 3 administrators. This distribution includes participants from various roles in the field of education and ensures that each group is represented. Apart from this, the table shows the demographic information of the participants and the duration of their use of artificial intelligence. The gender distribution among the participants is relatively balanced; there are 14 males and 12 females. The age range varies from 14 to 17 for students and 30 to 39 for teachers. The ages of educational technologists are between 32 and 34, and the ages of administrators are between 37 and 44. In terms of educational status, the majority of the participants are teachers and students at the secondary school level.

The duration of using artificial intelligence varies among the participants. There are 4 participants with 1 year of experience (2 students, 2 teachers), 8 participants with 2 years of experience (4 students, 1 teacher, 1 administrator, 2 educational technologists), 8 participants with 3 years of experience (4 students, 2 teachers, 2 administrators) and 6 participants with 4 years of experience (1 student, 3 teachers, 2 educational technologists). In general, most of the users have 2 or 3 years of AI usage experience. Those with the longest usage experience are educational technologists and some teachers. These findings reveal the different experiences and needs of various user groups in the adoption process of educational technologies. Students and teachers are predominantly represented, and the duration of AI use by these groups generally ranges between 2-3 years.

Data Collection Tools

Data collection tools that allow content and descriptive analysis such as focus interviews, interviews, observation and document analysis are preferred in the qualitative research method (Forrester & Sullivan, 2018). Interviews and observations were carried out in this study so as to collect information about the phenomenon. Interviews are referred to as the researcher gathering information by communicating with the study group remotely or face to face. The researcher tries to obtain detailed and in-depth information from the study group by preparing a specific list of questions on the subject. On the other hand, during an observation, the researcher collects information by observing events or situations in the participants' natural environments. The researcher observes the study group or event at specified time intervals and takes into account the interactions, behaviors and environmental factors of the participants (Merriam, 2015).

A semi-structured interview form was prepared concerning the problems discussed throughout the interviews. Four different semi-structured interview forms were created for each participant category. Each interview form consists of two dimensions. The first dimension consists of demographic information related to the participants. The second dimension consists of the interview questions. The interview questions consist of four questions. The questions in the interview form are as follows: (1) What is the effect of artificial intelligence supported learning management systems on students' academic performance? (2) On which issues do artificial intelligence supported learning management systems affect teacher adaptation process? (3) What is the effect of artificial intelligence supported learning management systems on educational materials and teaching methods? (4) What is the effect of artificial intelligence supported learning management systems on measurement and evaluation processes?

In this way, it is aimed to collect information from all stakeholders regarding the other stakeholders and the process. Ensuring that the questions were clear and understandable was aimed while creating the interview questions. By participating in learning-teaching environments, the researcher observed the experiences of teachers and students regarding the process.

Data Analysis Process

The data collection process started after determining the participants and data collection tools. In this process, if the researcher has not based the research problem on a sufficient theoretical framework and has not chosen the appropriate sample and data collection tools, problems arise in addressing the research problem (Creswell & Creswell, 2017). Interviews were conducted face-to-face or online, and their duration is indicated in minutes. The interviews coded S1 to S9 were conducted face-to-face and their duration varied between 10 and 15 minutes. The interviews coded H1, H4, H7 and H9 were conducted online, and their durations ranged from 16 to 23 minutes. The interviews coded H2, H3, H5, H6, H8 and H10 were conducted face-to-face and lasted between 18 and 24 minutes. The interview coded ET1 was conducted online and lasted 17 minutes. Finally, the interviews coded M1, M2 and M3 were conducted face-to-face and lasted between 18 and 23 minutes. This dataset is used to analyse the use of artificial intelligence applications in education and their effects on different interview methods and durations.

The interviews were carried out in classrooms where artificial intelligence learning management systems are used. During this period, teachers' adaptations to using the system

and learners' performances were examined. After completing the data collection process, the data obtained was subjected to content analysis. Content analysis refers to the detailed examination of the data obtained. As a result of content analysis, codes and themes are determined by the researcher. While codes and themes are being identified, the elements that are mostly repeated or emphasized by the study group among the collected data are defined as codes and themes (Merriam & Grenier, 2019). All these obtained codes and themes were supported by the notes taken during the observation.

Validity and reliability were taken into consideration throughout the data collection process and analysis of the research. The reason for this is because the researcher needs to control the results to be obtained against the event or situation discussed (Yıldırım & Şimşek, 2016). The following points were taken into consideration in terms of validity and reliability of this study. (1) Opinions of all the participants were considered for the validity of the research. Opinions were reviewed for opinions of a field expert. (2) The researcher played an active role during the observation. In addition, data obtained from the interviews were interpreted objectively. (3) Participants included in the study were given detailed information about the purpose and process of the study. (4) The collected data was kept confidential, and codes were given to the participants. (5) Participation in the study was based on voluntary basis. (6) All collected data were conveyed to the participants, and it was checked whether or not they were understood correctly. (7) Data was collected from multiple data sources about the same phenomenon. (8) According to the Cohen Kappa coefficient, the level of agreement in the analysis of the interviews was examined. Cohen's kappa coefficient was found to be 0.67 as a result of the evaluation of the data set by two evaluators. This result shows that there is a significant level of agreement between the evaluators. Thus, the reliability of the analysis process and the interpretability of the results were revealed.

Findings

Findings on the impact of artificial intelligence supported learning management systems on students' academic performance

The first sub-research question of the research is “What is the impact of artificial intelligence-supported learning management systems on student academic performance?”. Content analysis was carried out for the data obtained as a result of the interviews and were supported by observation notes. Results of the analyses are given on Table 2. The visualization of the schemes of the codes obtained in Table 2 is given in Figure 1.

Table 2. Themes and codes regarding the impact of artificial intelligence-supported learning management systems on student academic performance

Themes	Codes	Participants	Frequency
Systemically supportive reflections	Personalized education	ET1, ET2 S1, S2, S6, S7, S8, H1, H2, H4, H5, H6, H7, H9, H10, M1, M2, M3	18
	Facilitating learning	S4, S7, S8, S9, H2, H3, H5, H6, H8, H9, H10, M1, M2	13
	Distance education	ET1, S5, S8, S10, H1, H4, H5, H7, H10, M1, M2, M3	12
	Identifying learning speed	ET1, ET2, S2, S7, S8, S9, H3, H4, H7, H10, M1, M3	12
	Identifying student needs	ET1, ET2, S5, S8, S9, H6, H8, H10, M1, M2, M3	12
	Accessibility	ET1, S6, H1, H2, H4, H7, H9, M1, M2, M3	10
	Student-centered education	ET1, H1, H3, H4, H5, H6, H9, H10, M2, M3	10
	Feedback	ET1, S1, S2, S3, S5, S6, S7, S8, S9, M3	10
	Data-driven decision making	ET1, H1, H2, H5, H6, H9, H10, M1, M2	9
	Interaction	H7, H8, H10	3
	Gamification	ET2	1
Supportive reflections in terms of the learning process	Increase in learning motivation	S1, S2, S4, S7, S8, S9, H1, H2, H4, H5, H7, H8, H9, H10	14
	Permanent learning	ET1, S2, S4, S7, H1, H2, H3, H5, H6, H7, H8, M1, M3	13
	Focusing	H1, H2, H4, H5, H7, H8, H9	7
	Time management	ET2, H2, H4, H5, H8, H10, M1	7
	Collaborative work	ET1, ET2, H4, H6, H7, H10	6
	Research skill	H2, H7, H9	3
Negative reflections	Technology addiction	ET2, H2, H5, H9, H10	5

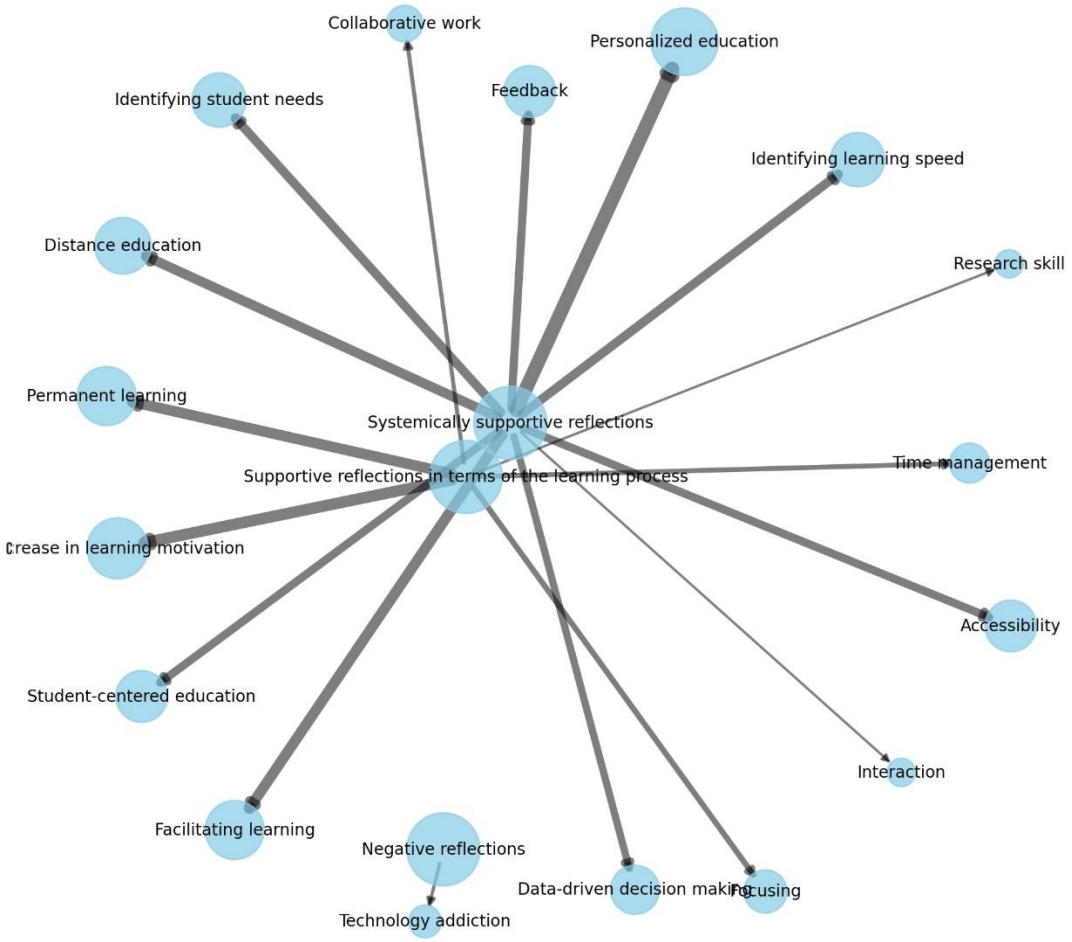

Figure 1. Visuals related to the themes and codes of Table 2

According to Table 2, there are three codes related to the impacts of artificial intelligence-supported learning management systems on students' academic performances: "systematically supportive reflections, supportive reflections in terms of the learning process and negative reflections". According to the systematically supportive reflection's theme, it is evident that the personalized education code has been especially emphasized by the participants. It can be stated that due to being a different learning-teaching method than traditional education, it affects the academic performance of students. Because it is believed that the student's own learning speed is the solution to the situation where each student's knowledge and learning level is different within the learning environment. In addition, since this tool is a distance education system supported by artificial intelligence, it is evident that the advantage of the system for the student is that it provides access to the student at any time and supports his or her ability to study. It can be stated that the emphasis on personalized education in the learning process increases students' motivation for learning. Interviews suggest that the only negative outcome is that it will lead to technology addiction. It can be underlined that observation notes obtained by the researcher in the learning environment are supported by the interview results. Various participant opinions concerning the systematically supportive reflection theme are given below:

"Learning needs of the students are fully detected in artificial intelligence-supported learning management systems. It facilitates the learning process of the

students by emphasizing personalized education." (ET1- Code for personalized education)
"There are times when the questions I ask are not clarified due to the large number of classroom environments, but with this system I receive instant feedback." (S5-Code for feedback)
"It is a great opportunity for students with respect to equality of opportunity in education." (M2- Code for accessibility)

Various participant opinions concerning the supportive reflections in terms of the learning process theme are given below:

"It is observed that students' motivation towards learning has significantly increased due to the change in our learning and teaching methods." (H9- Code for increase in learning motivation)
"It is sometimes difficult to carry out group work with my classmates in the classroom. This way we can work collaboratively." (H6- Code for collaborative work)
"They can get distracted in the classroom environment due to other students. However, they can concentrate easier this way." (H5- Code for Focusing)

Various participant opinions concerning the negative reflection's theme are given below:

"We can talk about maybe only one bad impact on students. That is technology addiction. Because students are exposed to too much screen even if it is for studying." (H2- Code for Technology addiction)
"The negative outcome is that along with a positive attitude towards technology, their addictions can increase too." (H10 - Code for Technology addiction)

Findings on the impact of artificial intelligence-supported learning management systems on students' teacher adaptation

The second sub-research question of the research is "What is the impact of artificial intelligence-supported learning management systems on teacher adaptation?". Content analysis was carried out on the data artificial intelligence as a result of the interviews and were supported by observation notes. Results of the analyses are given on Table 3. The visualization of the schemes of the codes obtained in Table 3 is given in Figure 2.

Table 3. Themes and codes regarding the impact of artificial intelligence-supported learning management systems on teacher adaptation

Themes	Codes	Participants	Frequency
Reflections on the teaching process	Teacher role shift	ET1, ET2, S1, S2, S4, S6, S7, S9, H1, H3, H4, H6, H7, H9, H10, M2,	16
	Classroom management	S5, H1, H2, H3, H4, H6, H7, H8, H9, H10	10
	Change in student tracking	ET1, ET2, H1, H2, H5, H8, H9, H10, M1, M3	10
	Reducing workload	ET2, H2, H3, H5, H6, H8, H9, H10,	8
	Change in lesson planning	ET1, H1, H3, H4, H6, H7, H10,	7
	Data-driven decision making	ET2	1
Adaptation during the educational transformation process	Technical difficulties	ET2, H1, H2, H4, H5, H6, H7, H9, H10	9
	Having mastery in technology	M1, M2, M3, H1, H7, H8, H9	7
	Adapting to technology integration	ET1, M2, H4, H7, H10	5
	Improving digital literacy skills	ET2, H8, H10, M1, M2	5
	In-service education	M1, H1, H7, H8	4
	Technology leadership identity	H1, H5, H8	3

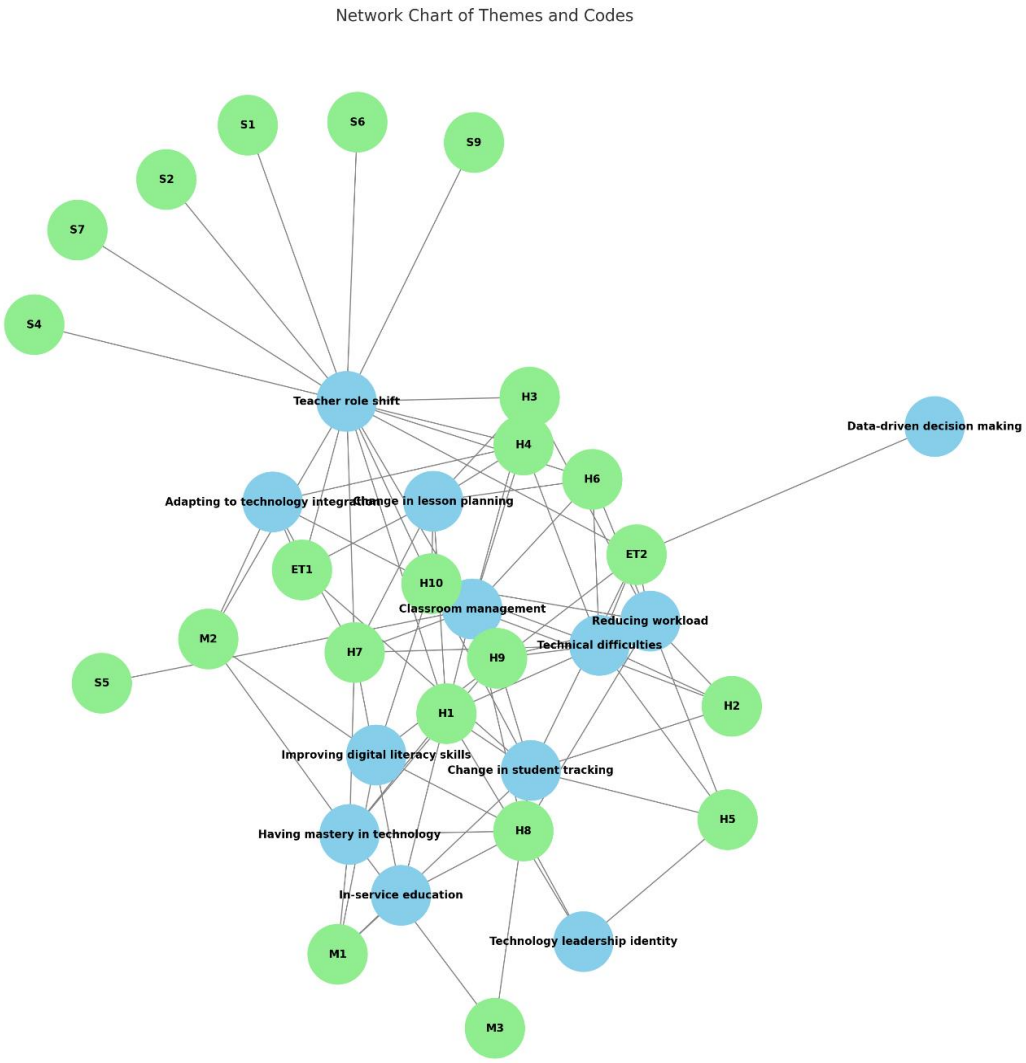

Figure 2. Visuals related to the themes and codes of Table 3

According to Table 3, there are two themes regarding the impact of artificial intelligence-supported learning management systems on teacher adaptation: "reflections on the teaching process and adaptation during the educational transformation process". It can be asserted that it leads to teacher role shifts during the learning process because it is student centered. In addition, it is observed that supporting student centered teaching has also led to a change in classroom management. It is observed that teachers' mastery of technology, technical difficulties and adaptation to technology integration processes have drawn attention during the educational transformation process. In this process, technology is just not integrated into the learning environment but also all learning and teaching processes are re-planned, thus this is clamed to affect the adaptation process. Various participant opinions concerning the reflections on the learning process theme are given below:

> *"Due to the learning-teaching technique changes, our course plans have consequently changed during this process." (H3-Code for change in lesson planning)*
> *"While we follow our students' interest in the lesson within the classroom, recording and tracking data in this way and making decisions accordingly has made the process even more systematic." (H8- Code for change in student tracking)*
> *"Our teachers' roles have changed during this process." (S1- Code for teacher role shift)*

Various participant opinions concerning adaptation during the educational transformation process theme are given below:

> *"I had difficulty when these artificial intelligence-supported systems were included in traditional education, we needed to have mastery in technology. But I was able to adapt in a short time." (H7- Code for adapting to technology integration)*
> *"In-service education organized by our school have made our job much easier." (H1-Code for in-service education))*
> *"Some technical issues and problems caused difficulty during the integration process." (H5- Code for technical difficulties)*

Findings on the impact of artificial intelligence supported learning management systems on educational materials and teaching methods

The third sub-research question of the research is "What is the impact of artificial intelligence-supported learning management systems on educational materials and teaching methods?". Content analysis was conducted for the data obtained as a result of the interviews and was supported by observation notes. Results of the analyses are given on Table 4. The visualization of the schemes of the codes obtained in Table 4 is given in Figure 3.

Table 4. Themes and codes regarding the impact of artificial intelligence-supported learning management systems on educational materials and teaching methods

Themes	Codes	Participants	Frequency
In terms of teachers	Developing educational strategies	ET1, H1, H4, H6, H7, H10, M1	7
	Reducing workload	ET2, M2, H3, H4, H8, H9, H10	7
In terms of students	Variety of materials	ET1, ET2, S2, S4, S5, S6, S8, S9, H1, H3, H4, H7, H10, M2 M3	15
	Visualizing the topics	ET1, S1, S2, S3, S7, S8, S9, H4, H5, H8, H10, M3	12
	Instant feedback	ET1, S1, S3, S4, S5, S6, S9, H5, H10, M2, M3	11
	Opportunity for repetition	ET1, H6, H10, S1, S2, S4, S6, S7, S9, M3	10
	Supporting individual work	ET1, S1, S2, S4, S8, S9, H6, H10, M1	9
	Personalized feedback	ET1, S4, S7, H2, H5, H7, H9, H10,	8
	Adaptation of materials	ET1, H6, H9, M1, M2, M3	6
	Permanent learning	ET1, H2, H4, H5, H7, H8	6
	Interactive learning	H3, H5, H9, M1, M2	5
	Supporting learning	ET1, H6, H8, M1, M3	5
	Attention grabbing and fun	S3, S4, S7, S8, S9	5
	Positive attitude	S2, S6, S9	3
	Improving problem solving skills	H5, H9	2
	Have digital skills	ET2	1

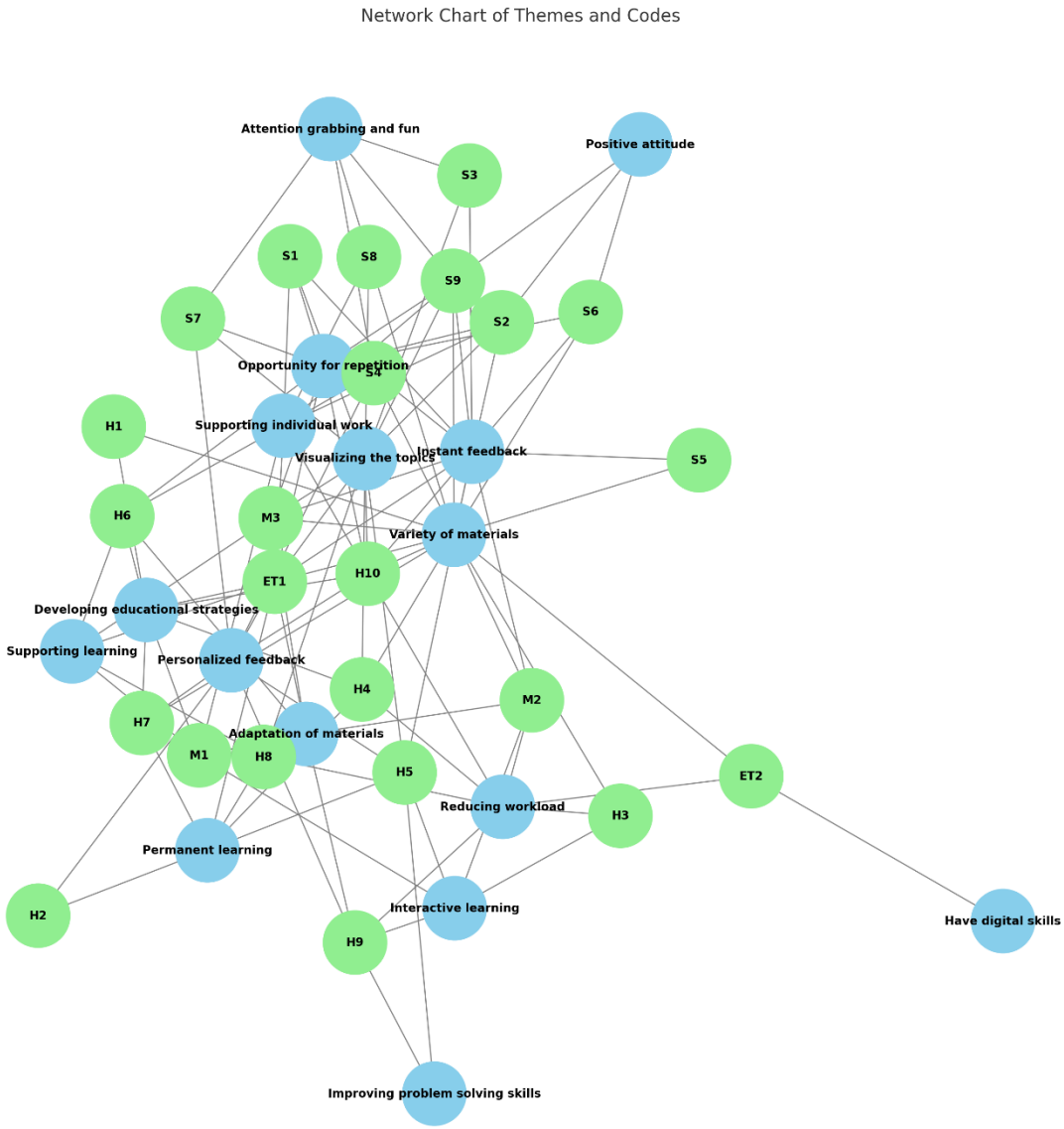

Figure 3. Visuals related to the themes and codes of Table 4

According to Table 4, there are two themes regarding the impact of artificial intelligence-supported learning management systems on educational materials and teaching methods: "In terms of teachers and in terms of students". It is believed that the change and variety of materials in terms of teachers leads to the development of educational strategies. In terms of students, it is thought that it supports learning by visualizing materials related to the subjects on the digital platform. It can also be stated that appealing to visual intelligence, personalized feedback and supporting individual work ensures permanent learning. One other way it supports learning is that it gives the opportunity for repetition. Various participant opinions concerning the in terms of teacher's theme are given below:

> *"Diversifying the teaching materials and making them appropriate to the level of the students has, as a teacher, reduced my workload." (H3- Code for variety of materials)*
>
> *"Students have moved away from traditional education through these systems and our strategies have eventually changed." (H4- Code for developing educational strategies)*

Various participant opinions concerning the in terms of student's theme are given below:

"Because it is an interactive system, I became curious about the lessons and generated a positive attitude towards learning." (S6-Code for interactive learning)
"I believe it increases academic success. Because it makes learning permanent. I can observe this in my lessons." (H4- Code for permanent learning)
"Through this system, learning styles, interests and learning speeds of students are identified. Student-oriented plans are made; thus, their learning is supported." (M1-
"The materials have made my learning process fun." (S8 Code for attention grabbing and fun- Code for supporting learning)

Findings on the impact of artificial intelligence supported learning management systems on educational assessment and evaluation processes

The fourth sub-research question of the research is "What is the impact of artificial intelligence-supported learning management systems on the measurement and evaluation processes?". Content analysis was carried out for the data obtained as a result of the interviews and were supported by observation notes. Results of the analyses are given on Table 5. The visualization of the schemes of the codes obtained in Table 5 is given in Figure 4.

Table 5. Themes and codes regarding the impact of artificial intelligence-supported learning management systems on measurement and evaluation processes

Themes	Codes	Participants	Frequency
Reflections on measurement and evaluation processes	Personalized feedback	ET1, S1, S2, S3, S4, S7, S9, H2, H7, H9, M1, M2, M3	13
	Objective evaluation	ET1, S3, S7, H2, H5, H8, H10, M1	8
	Process evaluation	ET1, H1, H4, H6, H7	5
	Data confidentiality	ET2, M1, M2	3

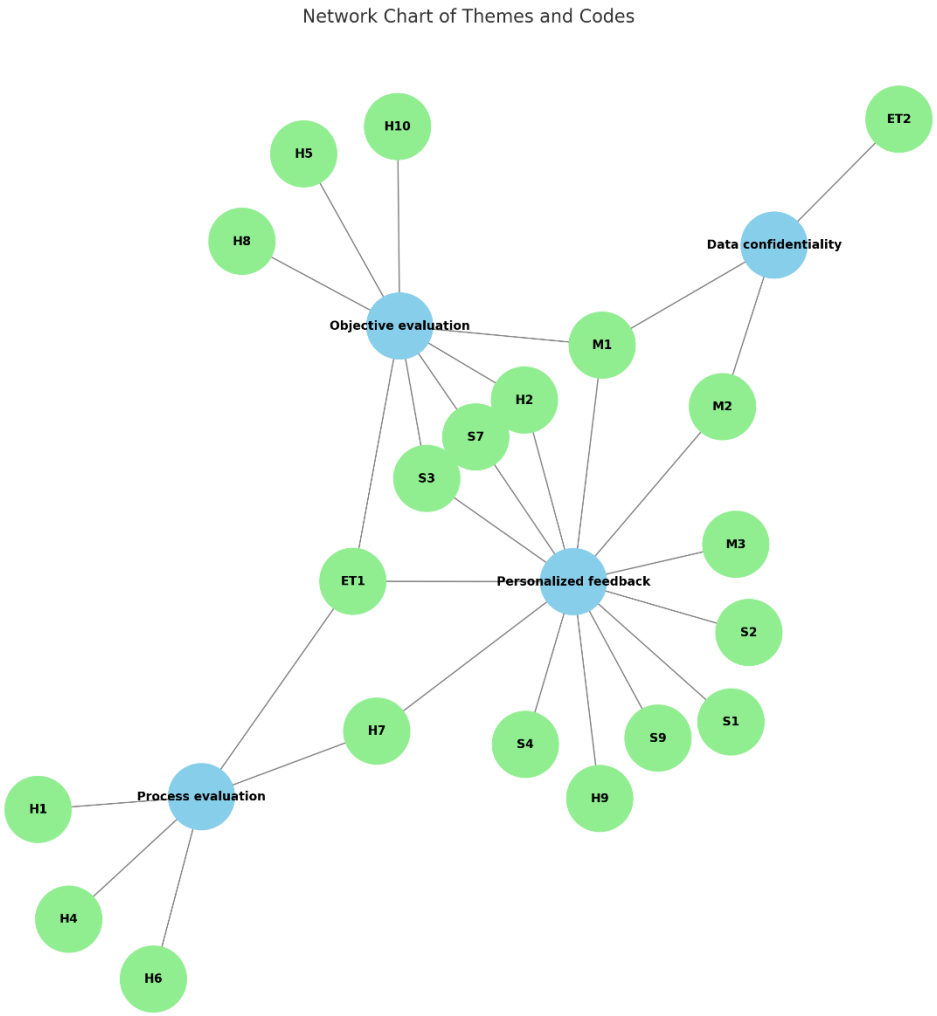

Figure 4. Visuals related to the themes and codes of Table 5

According to Table 5 there is one theme regarding the impact of artificial intelligence-supported learning management systems on measurement and evaluation processes: "Reflections on measurement and evaluation processes". Objective evaluation, data confidentiality, personalized feedback and process evaluation are the codes of measurement and evaluation processes. Developing a measurement and evaluation plan appropriate with the student's level is thought to be crucial for students. It can be said that unintentional mistakes in teacher evaluation are prevented in this way. Various participant opinions concerning the reflection in the measurement and evaluation process's theme are given below:

> *"We usually focused on outcome evaluation, but process evaluation became prominent because we were able to get feedback and track data about our students with artificial intelligence-supported systems." (H6- Code for personalized feedback)*

"When students are taken into consideration, I can say that they are subject to more objective evaluation in exams." (ET1- Code for objective evaluation)

> *"I believe that confidentially of data collected from the students is essential. Thus, it is important to be sensitive about reliability of the data." (M2- Code for data confidentiality)*

Discussion

Radical changes are also taking place in the field of education in today's rapidly changing technological environment. Artificial intelligence applications, which are considered as the pioneers of these changes, play a role that deeply affects digital transformation in education. Opportunities offered by artificial intelligence have the potential to reshape student learning experiences, optimize teachers' effectiveness, and make the operations of educational institutions more efficient. In this article, the impact of artificial intelligence applications on digital transformation in education is discussed in detail and the important effects of these technologies on education systems are analyzed. The effects of artificial intelligence technologies on digital educational transformation were revealed by the opinions and observations of teachers, administrators, students and an educational technologist throughout the research. Answers to the questions how artificial intelligence-supported learning management systems change students' academic performance; how artificial intelligence-based educational tools affect students' learning processes; how artificial intelligence-supported educational materials can change teaching methods; and their impact on measurement processes were sought. The limitations of this research are as follows: (1) the cultural context of the place where the research was conducted, (2) the acceptance and impact of artificial intelligence applications, (3) the use of qualitative data collection methods.

The impact of artificial intelligence supported learning management systems on students' academic performance

According to the first research question of the study, the effect of AI-supported learning management systems on students' academic performance is primarily the supporting aspects of the system. In the literature, there are many studies showings that learning management systems supported by artificial intelligence positively affect academic achievement due to providing personalized education (Martínez et al., 2023; Wang, 2023; Meletiadou, 2023). From a systemic perspective, it is seen that it positively affects students' academic achievement in many ways. The most striking result of this theme is individualized education. In the research conducted by Tissenbaum, Lane, Ybarra, and Nunez (UIUC, 2023), the significant impact of artificial intelligence-supported learning management systems on personalized learning is emphasized. In a study conducted by Pekmez, Çoban, Kılıç, and Duman (2024), as in this study, the positive effects on students' learning processes come to the fore as a result of considering individual differences and personalizing the learning process. In addition, one of the factors that artificial intelligence-supported learning management systems positively affect academic achievement is feedback. Aşık et al. (2023) stated in their study that advantages such as instant evaluation and feedback increase student achievement. In addition, he obtained results that it increases the learning speed, saves time by shortening the learning process of students, provides permanent learning and provides interesting information that increases students' motivation (Pekmez et al., 2024; Dashty et al., 2023). Parallel results were also found in this study. This result in the literature shows similar results regarding the supportive theme in terms of the learning process in this study. In addition, as in this study, Halagatti et al., (2023), Khan and Bose (2021) and Kaouni, et al., (2023) also emphasize the importance of artificial intelligence-supported systems to determine the needs of students. It was concluded that these systems support student-centered teaching. Jiao et al., (2022) also stated in their study that the effect of the student being active on academic achievement is important.

The effect of artificial intelligence supported learning management systems on teacher adaptation

In line with the findings, it was concluded that AI-supported learning management systems change and support teacher adaptation in various aspects. Karkouch and Mousannif (2022) also found that AI-supported learning management systems improve teacher adaptation. Aşık et al. (2023), who evaluated the impact of AI-supported learning management systems on teacher adaptation, concluded that artificial intelligence tools also help teachers in reducing workload, tracking students and developing teaching materials. Singh (2023) emphasizes that artificial intelligence supported learning management systems reduce the workload of teachers, especially in assessment processes. Sakalle et al., (2021) stated that it facilitates the work of teachers in their studies. Zhai et al., (2021) state that these tools minimize the workload of teachers and increase efficiency in teaching. However, in addition to these advantages, teachers also have challenging processes such as difficulties in integration processes, technical problems, and mastering technology. Because it is emphasized that teachers should master technology in the transformation process in education. Hindawi (2020) states that teachers' adaptation to new pedagogical approaches and the ability to incorporate artificial intelligence technologies into teaching techniques are becoming increasingly important. In the teaching process, it has also affected the processes of teachers to follow their students instantly (Timms, 2016).

The impact of artificial intelligence supported learning management systems on educational materials and teaching methods

In the effect of artificial intelligence-supported learning management systems on educational materials and teaching methods, the importance of supporting material diversity and individual study for students has come to the fore. In the study conducted by Zhai et al. (2021), it was found to be very useful in creating personalized learning materials. In addition, it was stated that students' access to information with various materials through artificial intelligence-supported learning management systems increases efficiency in terms of learning. As in this study, Zhang (2023) also found in his study that artificial intelligence supported learning management systems create personalized and adaptive learning and educational materials for students and this has a positive effect on transformation. Adablanu (2023) states that these systems support learning through adaptive education. In this study, it was concluded that these systems support learning. Sharma et al., (2021) in his research, he emphasizes that these systems help teachers to develop training strategies, as the parallel result obtained in this study. One result that draws attention to the impact of AI-supported learning management systems on educational materials and teaching methods is interactive learning. Seo et al., (2021) found that AI-supported systems have a positive effect on student-instructor interaction.

The impact of artificial intelligence supported learning management systems on educational assessment and evaluation processes

In this study, it was concluded that the artificial intelligence learning management system positively affects the assessment and evaluation processes, especially because it provides customized feedback and objective evaluation. When the literature is analyzed, it is seen that the objective evaluation of these systems is one of the factors affecting the transformation (Martínez-Comesaña et al., 2023; Anuyahong et al., 2023; Nithiyanandam, et al., 2022) However, it was determined that the protection of students' personal data should not be ignored in terms of data privacy.

Conclusion

As a result of the study, the effects of AI-supported learning management systems on students' academic performance were categorized under three main codes: systemically supportive reflections, supportive reflections in terms of learning process and negative reflections. In the theme of systemically supportive reflections, the participants especially emphasized the importance of individualized education. AI-supported learning management systems provide individualized education by allowing each student to progress according to their own learning pace. In addition, the remote access of these systems brings the advantage of allowing students to study and access information at any time. Increased motivation was observed in students, but it was also stated that there may be negative aspects such as technology addiction.

The effects of AI-supported learning management systems on teacher adaptation were analyzed under two main themes: reflections on the teaching process and adaptation in the transformation process in education. The creation of a student-centered learning environment by these systems has led to changes in the role of teachers and classroom management. It was found important for teachers to master technology and adapt to the technology integration process. In this process, it was determined that teaching strategies and learning-teaching processes should be re-planned.

The effects on educational materials and teaching methods were categorized under two themes in terms of teachers and students. For teachers, the change and diversification of materials contributed to the development of educational strategies. For students, visualization of the materials presented on digital platforms, appealing to visual intelligence and providing personalized feedback supported permanent learning. In addition, the possibility of repetition was another factor that reinforced learning.

Finally, the effects on measurement and evaluation processes were analyzed under a single theme. Codes such as objective evaluation, data privacy, customized feedback and process evaluation were collected under this theme. Artificial intelligence minimizes the mistakes made by teachers in the assessment process by making customized assessment according to the knowledge level of students. These results reveal that artificial intelligence-supported learning management systems make significant contributions to the digital transformation process in education. It both increases the academic performance of students and supports the adaptation process of teachers. In addition, it provides objectivity and accuracy in measurement and evaluation processes by providing innovations in educational materials and teaching methods. However, negative aspects such as technology addiction should also be taken into consideration. In line with these results, the following suggestions were made:

(1) Given the success of AI-supported learning management systems in providing individualized education, educational institutions should be encouraged to adopt such systems.
(2) Guidance and training programmes on the use of technology should be organized for students and teachers.
(3) Since it is important for teachers to master technology and adapt to the technology integration process, continuous professional development programmes should be organized.
(4) Efforts should be made to diversify and visualize educational materials.

(5) Repetition and reinforcement opportunities offered by artificial intelligence supported systems should be used.
(6) Necessary measures should be taken to ensure that students' data are stored securely, and their privacy is protected.
(7) It can be studied whether similar results can be obtained in different educational institutions such as schools at socioeconomic levels or public schools.
(8) Future research could examine the long-term effects of these systems and their applicability in different educational settings.

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