

Developing and Evaluating an AI-Based Information Technologies and Software Course Using the ASSURE Model

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Developing and Evaluating an AI-Based Information Technologies and Software Course Using the ASSURE Model*

* This study is derived from the doctoral dissertation of Muhammed Ali Özkan, conducted under the supervision of Prof. Dr. Harun Şahin at the Faculty of Education, Akdeniz University.

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Abstract

This study aimed to develop an artificial intelligence (AI)-based instructional design grounded in the ASSURE Model for a middle school Information Technologies and Software (ITS) course, refine the design based on findings from a pilot implementation, and evaluate its feasibility in an authentic classroom setting using multiple data sources. The study was conducted in two phases, with 35 sixth-grade students participating in the pilot implementation and 21 participating in the main implementation. The pilot phase served as a formative evaluation, while a convergent parallel mixed-methods design was adopted in the main implementation. A one-group pretest-posttest design was used for the quantitative strand and a case study design for the qualitative strand. Data were collected through the ITS Literacy Scale, the Motivation toward the ITS Course Scale, focus group interviews, and researcher notes. Following the main implementation, significant increases were observed in ITS literacy with a medium effect size and in motivation toward the ITS course with a large effect size. Qualitative findings indicated that students actively engaged in developing digital products, questioning and refining AI-generated outputs, problem solving, collaboration, and evaluating ethical issues. Based on technical access, prompt-writing, and time-management difficulties identified during the pilot phase, a two-week preparatory period was added before the main implementation. The findings suggest that the educational value of AI in the ITS course was associated less with the tools themselves than with the systematic integration of learner characteristics, instructional objectives, production tasks, teacher guidance, iterative improvement, and ethical evaluation. The study provides a practice-based example of integrating AI into a middle school ITS course through an instructional-design-centered approach.

Keywords: ASSURE Model, artificial intelligence, Information Technologies and Software, ITS literacy, motivation, instructional design

Introduction

Recent advances in artificial intelligence (AI) technologies have prompted a reconsideration of teaching and learning processes in educational settings. With the growing prevalence of generative AI applications, teachers and students have increasingly begun to use these technologies for a range of purposes, including content creation, planning learning activities, providing personalized feedback, and supporting problem solving [1,2]. These developments have moved AI beyond the status of a novel digital tool and made its integration into instructional processes a prominent topic in educational research [3,4]. At the same time, the educational value of AI tools is increasingly understood to depend not only on their technological capabilities but also on how well they are aligned with instructional objectives, learner characteristics, learning activities, and assessment processes [5,6]. Meaningful and sustainable use of AI in education therefore requires systematic instructional design grounded in pedagogical principles [6].

Middle school represents an important stage in which students' engagement with digital technologies intensifies and their competencies for using these technologies consciously, safely, and productively continue to develop [7]. In Türkiye, the Information Technologies and Software (ITS) course is compulsory in Grades 5 and 6 and aims to help students develop basic information technology literacy, problem-solving and algorithmic thinking skills, and ethical participation in the digital world [8]. The curriculum includes complementary competency areas such as information and communication technologies, ethics and security, research and collaboration, problem solving and programming, and digital product creation. This structure adopts a holistic approach that extends beyond the operational use of technology to include evaluating information, developing digital content, observing security principles, and producing tangible outcomes through technology [9-10]. Accordingly, ITS literacy is not limited to the ability to use digital tools; rather, it encompasses a set of interrelated competencies such as evaluating information and data, producing digital content, solving problems, ensuring safety, and using technology purposefully [11]. As AI applications become increasingly visible in educational curricula and students' everyday digital experiences, the ITS course has gained further importance as a meaningful context in which these technologies can be addressed in age-appropriate, critical, and productive ways [12].

AI tools offer various opportunities to support students' development of digital content, generation of alternative solutions, receipt of feedback, and revision of their products within the ITS course. The capacity of generative AI to produce text, images, and code may contribute to diversifying learning activities in which students engage with technology productively [1,2]. However, transforming these opportunities into pedagogical value at the middle school level requires selecting tools appropriate to students' age and developmental characteristics, encouraging critical examination of

AI-generated content, and preserving the teacher's guiding role [13]. Issues such as data privacy, inaccurate or misleading content, bias, copyright, and reliability also necessitate that instructional processes be planned in accordance with principles of ethical and safe use [5]. In addition, supporting students in using AI tools critically, responsibly, and purposefully is among the central orientations of contemporary AI competency frameworks in education [14]. AI integration in the ITS course should therefore be approached not as a matter of tool selection alone, but as an instructional design process in which objectives, activities, participation, and assessment are coherently aligned.

Instructional design models provide an important framework for transforming technology use into a systematic and pedagogically justified instructional process. In the present study, the ASSURE Model was adopted to structure the instructional process. Its emphasis on learner characteristics, alignment between instructional objectives and media/material use, active learner participation, and continuous evaluation and revision corresponds closely with the aims and implementation context of this study [15-17]. Accordingly, AI tools were not treated as digital components added to instruction after the fact; rather, they were incorporated as an integral part of the instructional design developed through the ASSURE Model.

When evaluating AI-based instructional processes in the ITS course, it is important to consider students' motivation toward the course in addition to cognitive and skill-related outcomes. Course-related motivation is closely associated with students' participation in activities, persistence in tasks, effort, and willingness to assume responsibility for learning [18,19]. Experiences such as developing products, making choices, receiving rapid feedback, and collaborating with peers may support motivation; however, whether this potential is realized depends less on the technology itself than on how the learning process is structured [18,20].

Research on AI in education has expanded substantially in recent years, with studies focusing on teacher and student perceptions, awareness and attitudes toward AI, AI literacy, lesson planning and instructional material development, and a range of learning outcomes [1,3,4,21]. At the middle school level, applied studies have examined the effects and implications of AI-supported instruction for AI literacy, academic achievement, motivation, attitudes, and learning experiences across subject areas such as science, social studies, visual arts, and technology design [22-26]. However, these studies have generally focused on particular subjects, AI applications, or learning outcomes, while evidence remains limited regarding the systematic integration of AI tools into a middle school ITS course through an established instructional design model. Studies combining the ASSURE Model with AI have mainly addressed preservice teachers' AI-supported material development experiences, applied course design in higher education, or lesson-planning and design frameworks for different educational levels [27-30]. There is therefore a need for classroom-based studies in which an ASSURE Model-based instructional design for middle school ITS is developed, refined through pilot findings, and evaluated by examining changes in

students' ITS literacy and course motivation together with student views and researcher notes.

Accordingly, this study aimed to develop an AI-based instructional design grounded in the ASSURE Model for a middle school ITS course, refine the design based on findings from a pilot implementation, and evaluate its feasibility in an authentic classroom setting through multiple data sources. Changes in students' ITS literacy and motivation toward the ITS course were examined quantitatively, while the implementation process was evaluated holistically through student views and researcher notes. The study is expected to contribute to the literature by providing a practice-based instructional design for the systematic integration of AI tools into a middle school ITS course through the ASSURE Model and by reporting the design, implementation, and evaluation processes together.

Accordingly, the study addressed the following research questions:

1. What revisions were made to the instructional design following the pilot implementation?
2. Did students' ITS literacy significantly change following the implementation?
3. Did students' motivation toward the ITS course significantly change following the implementation?
4. What were students' views of the AI-based instructional process?
5. How did the instructional process unfold according to the researcher notes?
6. In what ways did the quantitative and qualitative findings converge or diverge?

Method

2.1 Research Design

The study was conducted in two sequential phases involving the development and evaluation of an AI-based instructional design. The pilot implementation was used for formative evaluation to refine the instructional design, whereas a convergent parallel mixed-methods design was adopted to evaluate the revised design during the main implementation [31,32]. In a convergent parallel design, quantitative and qualitative data are collected within the same phase of the study, analyzed independently, and then compared and integrated during the interpretation stage [32,33]. Accordingly, during the main implementation, quantitative and qualitative data were collected within the same overall period, analyzed separately, and subsequently integrated during interpretation to provide a more comprehensive understanding of the research problem.

For the quantitative strand, a one-group pretest-posttest design was used to examine changes in students' ITS literacy and motivation toward the ITS course before and after the implementation of the instructional design. In this design, the same group of

participants completes a pretest before the intervention and a posttest afterward, and the change between the two measurements is examined statistically [34,35]. Although a one-group pretest-posttest design provides quantitative evidence of changes observed following an intervention, the absence of a control group means that threats to internal validity, including history, maturation, testing effects, and statistical regression, cannot be fully ruled out [36]. Therefore, the aim of the present study was not to compare the effectiveness of alternative instructional approaches or to make strong causal claims, but rather to implement the developed instructional design in an authentic classroom setting and evaluate the implementation process through multiple data sources. Quantitative findings were consequently interpreted as changes observed in students' scores following the implementation and were considered together with qualitative findings derived from student views and researcher notes.

For the qualitative strand, a case study design was adopted to examine in detail how students experienced the implementation process and how the instructional design functioned in the classroom [37,38]. Case study research enables an in-depth and holistic investigation of a bounded event, program, or process within its natural context [37,39]. In the present study, the bounded case was the ASSURE Model-based AI instructional process implemented with sixth-grade students in a public middle school over a total of eight weeks, comprising a two-week preparatory period and a six-week instructional implementation. The analysis focused on how this instructional process was enacted in the classroom and how students experienced it. Student views and researcher notes were therefore examined together to provide a more comprehensive understanding of the implementation process and to support the contextual interpretation of the quantitative findings through the use of multiple data sources [39,40].

Ethical Approval

This study was approved by the Akdeniz University Social Sciences and Humanities Scientific Research and Publication Ethics Committee on November 12, 2024 (Decision No. 474; Document No. 1058466). All methods involving human participants were performed in accordance with the principles of the Declaration of Helsinki and the Directive on the Ethics of Scientific Research and Publication for Higher Education Institutions in Türkiye, as well as applicable institutional ethical standards and regulations. Written informed consent was obtained from the parents or legal guardians of all participating students, and voluntary assent was obtained from the students prior to participation. Separate permission for audio recording of the focus group interviews was obtained from both the parents or legal guardians and the participating students.

2.2 Participants

The study was conducted in two successive phases: a pilot implementation and a main implementation. The pilot implementation involved 35 sixth-grade students attending a public middle school in Türkiye during the 2024-2025 academic year. Based on the findings obtained from the pilot implementation, the instructional design was revised

as necessary. The main implementation was then conducted with 21 sixth-grade students attending the same public middle school during the 2025-2026 academic year. Thus, the pilot and main implementations were carried out in different academic years with independent groups of students.

In both phases, participants were selected through convenience sampling from classes in which the researcher taught the ITS course and was able to implement the instructional design within the natural classroom setting [41,42]. The sixth-grade level was selected because the ITS course is compulsory at this grade level and because students had prior course experiences relevant to the digital production activities addressed in the study [8]. Demographic characteristics of the pilot and main implementation groups are presented in Table 1.

Table 1 Demographic Characteristics of the Participants

Implementation	Girls	Boys	Total
Pilot implementation	16	19	35
Main implementation	7	14	21

Following the main implementation, students who participated in the focus group interview were selected through criterion sampling, a form of purposive sampling [43]. The selection criteria included ensuring that at least one student from each working group formed during the implementation participated in the interview, maintaining gender diversity, and including students who had attended the implementation regularly and were willing to share their views. The selection process also aimed to reflect variation in levels of participation and implementation experiences. Based on these criteria, eight students participated in the focus group interview. This approach was intended to enable a more comprehensive evaluation of the implementation process through diverse student experiences.

2.3 Development of the AI-Based Instructional Design

The implementation process was structured into three main phases: pre-implementation preparation, the instructional intervention, and post-implementation evaluation. During the instructional intervention, the stages of the ASSURE Model were followed systematically. The overall flow of the research process is presented in Figure 1.

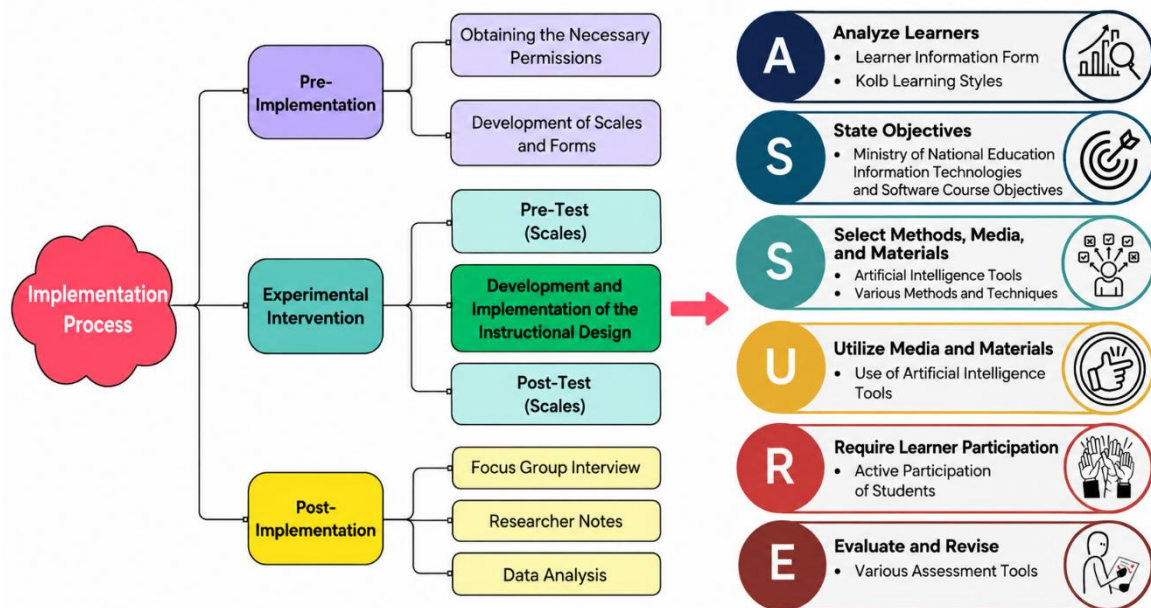


Fig. 1 Overview of the Implementation Process and the Integration of the ASSURE Model into the Instructional Design

2.3.1 Learner Analysis and Its Implications for the Design

The development of the instructional design began with the learner analysis stage of the ASSURE Model. This analysis examined students' age and gender characteristics, access to technological devices, prior knowledge of AI, experience with digital tools, readiness for the ITS course, learning expectations, and learning styles. The findings showed that although students generally had access to digital tools, they needed support in distinguishing AI from other digital platforms, performing certain basic technical operations, and using digital tools for productive purposes. Students were also found to be interested in technology and to prefer activities involving hands-on practice, design, games, software, and the development of tangible products.

According to the Kolb Learning Style Inventory III, 9 students (42.9%) were classified as divergers, 6 (28.6%) as accommodators, 4 (19.0%) as convergers, and 2 (9.5%) as assimilators. The inventory results indicated that diverging and accommodating learning preferences were more prevalent in the class. These findings were considered together with other learner analysis data concerning students' readiness, technology-use experiences, and learning expectations. Accordingly, the lesson plans incorporated visual examples, teacher modeling, group discussions, guided practice, trial-and-error activities, real-life problems, AI-supported product development, and reflective activities. Given differences in students' readiness and technical skills, tasks were scaffolded progressively, instructions were made more explicit and concrete, and teacher and peer support was provided when needed.

2.3.2 Structuring the Instructional Design

Based on the learner analysis, the objectives, content, instructional methods, materials, learning activities, and assessment components of the instructional design were structured in accordance with students' characteristics, readiness levels, and learning preferences. Throughout the design process, the ASSURE Model stages of stating objectives; selecting and utilizing methods, media, and materials; requiring learner participation; and evaluating and revising the instructional process were followed systematically. The instructional design proceeded through four stages: initial design, pilot implementation, evaluation and refinement, and main implementation. AI tools were integrated into the lesson plans not merely as technological resources but as pedagogical components aligned with ITS curriculum objectives and learner characteristics.

In the initial stage, the instructional design was developed with consideration of the characteristics of the pilot group. Students' access to technology, digital competencies, readiness for AI-based activities, and learning styles were analyzed, while instructional objectives were determined in accordance with the ITS Course Curriculum issued by the Turkish Ministry of National Education. The instructional activities were structured around production-oriented learning experiences in which students could develop digital products such as images, videos, audio, text documents, presentations, and spreadsheets using AI tools. Within this framework, generative AI tools such as ChatGPT, Canva AI, DALL·E, Gamma, and Runway were integrated into the instructional process in alignment with the intended learning objectives.

2.3.3 Pilot Implementation and Refinement of the Instructional Design

The pilot implementation was conducted over six weeks during the second semester of the 2024-2025 academic year. At the end of the implementation, quantitative findings obtained from the ITS Literacy Scale and the Motivation toward the ITS Course Scale were considered together with qualitative findings derived from student views and researcher notes. Because the primary purpose of the pilot implementation was not to test the effectiveness of the instructional design but to evaluate its feasibility and identify aspects requiring improvement, the quantitative findings were not reported in detail. Revisions to the instructional design were based primarily on implementation needs identified through student views and researcher notes, while the scale results were used as supplementary evidence in the overall evaluation of the pilot phase.

Several revisions were made to the instructional design based on the pilot findings. In particular, students were found to have gaps in the basic digital skills required for effective use of AI tools. Difficulties related to email use, access to the Education Information Network (EBA), registration for AI tools, and effective prompt construction consumed considerable instructional time. Therefore, a two-week preparatory program addressing these needs was incorporated into the instructional design before the main implementation. The purpose of this preparatory period was to enhance students' digital readiness and facilitate a more efficient instructional process.

2.3.4 Main Implementation

The revised instructional design was implemented during the first semester of the 2025-2026 academic year. The main implementation lasted eight weeks in total, comprising a two-week preparatory program followed by six weeks of AI-based instruction. The weekly instructional focus, core activities, AI tools used, and ethical and critical dimensions addressed throughout the implementation are summarized in Table 2.

Table 2 Weekly Instructional Content of the Main Implementation

Week	Instructional Focus	Core Activity/Product	Tools and AI Support Used	Ethical and Critical Dimension
1	Digital preparation: email and EBA use	Secure login and logout procedures for email accounts, creation of strong passwords, access to EBA, posting comments in discussion areas, and peer feedback	Email and EBA	Strong passwords, protection of personal information, secure account use, and netiquette
2	Preparation for AI use and prompt writing	Registration and login procedures for AI tools, use of interfaces, learning the components of effective prompts, and refining prompts	Accessible AI tools such as ChatGPT, Gemini, or Copilot	Avoiding the disclosure of personal data, critically evaluating AI-generated outputs, and safe use
3	AI-supported image generation and editing	Creating a “Safe Digital Life Poster”; evaluating and refining the initial prompt and editing the generated visual	Canva AI, DALL·E 3; alternatively, Artbreeder, DeepAI, and Krea.ai	Copyright, source attribution, human labor, authenticity of AI-generated images, and safe digital life
4	AI-supported video creation and editing	Producing a 10–20-second micro public service announcement entitled “Act Safely in the Digital World”	Canva AI, Synthesia, Runway, CapCut, with Monica as a supplementary tool	Misleading videos, AI-generated avatars, personal data, copyright, and responsible use of synthetic content
5	AI-supported audio and music creation and editing	Producing a 10–20-second jingle on digital safety and, optionally, a short voice-over	Suno, Riffusion, Murf AI or ElevenLabs, and Vocal Remover	Voice imitation, identity security, misleading audio content, human labor, and copyright in music
6	AI-supported text	Preparing and formatting a one-page document	ChatGPT, Gemini, Copilot, DeepSeek,	Treating AI-generated text as a draft, checking

Week	Instructional Focus	Core Activity/Product	Tools and AI Support Used	Ethical and Critical Dimension
	document creation and editing	entitled “Digital Citizenship Guide”	Canva Docs, and Gamma Document	inaccurate information, citing sources, and disclosing AI assistance
7	AI-supported presentation creation and editing	Preparing a 5–6-slide presentation entitled “Stay Safe in the Digital World”	Canva Presentations, Gamma Presentation, and SlideAI	Verifying information, identifying the sources of visuals, disclosing AI assistance, and originality
8	AI-supported spreadsheet creation and editing	Creating tables, calculations, and graphs using data on “Our Class’s Digital Habits”	Google Sheets, GPTEExcel, and Canva Sheets as an alternative	Protecting personal data, checking AI-suggested formulas, ensuring data accuracy, and considering the effects of incorrect calculations on decision making

During the implementation, a gradual and cumulative progression was followed across the weeks. Skills acquired during the preparatory program, including access to digital tools, safe use, and prompt writing, were transferred to subsequent activities involving the development of images, videos, audio, text documents, presentations, and spreadsheets. Each week incorporated a prompt-output-evaluation-refinement cycle, requiring students to examine, revise, and evaluate AI-generated outputs in terms of accuracy, safety, copyright, originality, and the protection of personal data rather than accepting the outputs directly.

The lesson plans used in the main implementation were prepared in accordance with the stages of the ASSURE Model. For each week, learning objectives, instructional methods and techniques, media and materials, activities designed to ensure learner participation, and assessment procedures were planned in detail. The lesson plans for the two-week preparatory program and the six-week AI-based instructional period are provided in Appendix 1.

Quantitative data, focus group interview data, and researcher notes obtained from the main implementation were analyzed separately and subsequently interpreted together to provide a holistic evaluation of the feasibility of the instructional design and students’ learning experiences.

2.4 Data Collection Instruments

The data collection instruments were selected to support both the planning and evaluation of the instructional design developed in accordance with the ASSURE Model. The Learner Analysis Information Form and the Kolb Learning Style Inventory

III were used to identify student characteristics during the development of the instructional design. The ITS Literacy Scale, the Motivation toward the ITS Course Scale, semi-structured focus group interviews, and researcher notes were used to evaluate the instructional design. In this way, quantitative and qualitative data were considered together to support methodological triangulation.

2.4.1 Learner Analysis Instruments

As part of the Analyze Learners stage of the ASSURE Model, the Learner Analysis Information Form and the Kolb Learning Style Inventory III were used to identify students' individual and contextual characteristics. Findings obtained from these instruments guided the adaptation of the instructional design to student characteristics.

2.4.1.1 Learner Analysis Information Form

The Learner Analysis Information Form was developed by the researcher in accordance with the Analyze Learners stage of the ASSURE Model to identify students' demographic characteristics, socioeconomic backgrounds, access to technology, entry-level competencies, and readiness for AI-based activities. During development of the form, the relevant literature was reviewed, with particular attention to learner characteristics, technology use, digital readiness, and variables that may influence AI-based learning processes.

To establish the content and face validity of the draft form, expert opinions were obtained from specialists in curriculum and instruction, educational measurement and evaluation, psychological counseling and guidance, as well as ITS teachers. The linguistic appropriateness and clarity of the form were also reviewed by experts in Turkish language education. Following revisions based on expert feedback, the form was piloted with 10 students at the same grade level who were not included in the study group, and the final version was prepared based on their feedback.

The form included questions designed to identify students' demographic characteristics, socioeconomic backgrounds, access to technology, basic digital skills, previously used digital tools, and prior knowledge and experience related to AI. Findings from the form were used in selecting AI tools, planning instructional activities, and adapting the instructional design to learner characteristics.

2.4.1.2 Kolb Learning Style Inventory, Version III

The Kolb Learning Style Inventory III, developed by Kolb [44] and adapted into Turkish by Evin Gencil [45], was used to identify students' learning preferences. Based on the dimensions of concrete experience, reflective observation, abstract conceptualization, and active experimentation, the inventory classifies learners into four learning styles: diverging, assimilating, converging, and accommodating. In the present study, the inventory was not used as an outcome measure; rather, it was used to provide supplementary information about students' learning preferences during the Analyze

Learners stage of the ASSURE Model and to inform the instructional design together with other learner analysis data.

2.4.2 Information Technologies and Software Literacy Scale

The ITS Literacy Scale, developed by the researcher specifically for this study, was used to assess students' ITS literacy levels. The five-point Likert-type scale consists of 24 items across four subdimensions, with possible total scores ranging from 24 to 120. The subdimensions are Fundamentals of Information Technologies, Ethics and Security; Communication, Research and Collaboration; and Product Creation. During scale development, an initial pool of 98 items generated through a literature review was reduced to 73 following preliminary language and content evaluations. Based on the feedback of eight experts in educational measurement and evaluation, computer and instructional technologies, curriculum and instruction, psychological counseling and guidance, and Turkish language education, a 35-item trial form was developed.

Exploratory factor analysis was conducted using data from 442 sixth-grade students attending six middle schools in one district in Türkiye. Following item and factor analyses, 11 items were removed, yielding a 24-item, four-factor structure. The Kaiser–Meyer–Olkin value was .928, and Bartlett's test of sphericity was significant, $\chi^2(276) = 7062.264$, $p < .001$. Factor loadings ranged from .729 to .913, and the four-factor structure explained 69.236% of the total variance. Cronbach's alpha coefficients for the subdimensions ranged from .810 to .945, while the overall alpha coefficient was .921. The resulting structure was then tested through confirmatory factor analysis using an independent sample of 410 sixth-grade students. The CFA results indicated acceptable to good model fit: $\chi^2/df = 1.964$, CFI = .99, NFI = .99, GFI = .91, IFI = .99, and RMSEA = .049. In the CFA sample, Cronbach's alpha coefficients for the subdimensions ranged from .768 to .941, and the overall alpha coefficient was .914. Composite reliability values above .70 for all subdimensions further supported the reliability of the measurement model. These findings indicate that the scale provides adequate evidence of validity and reliability for assessing students' ITS literacy.

2.4.3 Motivation toward the Information Technologies and Software Course Scale

The Motivation toward the ITS Course Scale, developed by the researcher for this study, was used to assess students' motivation toward the ITS course. The five-point Likert-type scale consists of 19 items representing a single factor, with possible total scores ranging from 19 to 95. During scale development, an initial pool of 74 items generated through a literature review was reduced to 52 following preliminary language and content evaluations. Based on the feedback of nine experts in educational measurement and evaluation, computer and instructional technologies, curriculum and instruction, psychological counseling and guidance, and Turkish language education, a 20-item trial form was prepared.

Exploratory factor analysis was conducted using data from 442 sixth-grade students attending six middle schools in one district in Türkiye. One item with a factor loading of .35 was removed, resulting in a 19-item unidimensional structure. The Kaiser–Meyer–Olkin value was .982, and Bartlett’s test of sphericity was significant, $\chi^2(171) = 6498.619$, $p < .001$. Item factor loadings ranged from .689 to .879, the single-factor structure explained 62.012% of the total variance, and Cronbach’s alpha was .966. The resulting structure was then tested through confirmatory factor analysis using an independent sample of 409 sixth-grade students. The CFA results indicated acceptable to good model fit: $\chi^2/df = 2.958$, CFI = .99, NFI = .99, GFI = .90, IFI = .99, and RMSEA = .069. In the CFA sample, Cronbach’s alpha was .973, composite reliability was .972, and average variance extracted was .667. These findings indicate that the scale provides adequate evidence of validity and reliability for assessing motivation toward the ITS course.

2.4.4 Focus Group Interview Form

A semi-structured Focus Group Interview Form was used to examine in depth students’ learning experiences, perceptions, and evaluations of the implementation process within the ASSURE Model-based AI-supported ITS course. During development of the form, the relevant literature was reviewed, and an initial draft consisting of 10 main questions was prepared in line with the aims of the study. The draft was reviewed by seven experts in educational measurement and evaluation, curriculum and instruction, psychological counseling and guidance, and Turkish language education with respect to alignment with the research aims, scope, appropriateness for the student level, and adequacy of probing questions.

Based on expert recommendations, repetitive questions and those weakly related to the research aims were removed, some questions were combined, and probing questions were strengthened. The revised form consisted of six main questions supported by follow-up probes. To evaluate comprehensibility and feasibility, pilot interviews were conducted with five students at the same grade level who were not included in the study group. Some items were subsequently revised based on student feedback before the form was finalized.

The form was designed to elicit not only students’ cognitive evaluations of the implementation but also their affective responses and individual experiences. This supported the contextual interpretation of the quantitative findings and a more holistic evaluation of the AI-based instructional design from the students’ perspective.

2.4.5 Researcher Notes

Researcher notes were used to document the classroom implementation process in detail. During each lesson session, observations were recorded regarding students’ participation in activities, their use of AI tools, difficulties encountered, noteworthy student responses, and the implementation of instructional activities. At the end of each

implementation week, these observations and reflections were systematically organized in a computer-based Researcher Notes Form.

The researcher notes were used not only to describe the implementation process but also to examine the alignment between the planned activities and their actual classroom enactment and to identify areas requiring further improvement. These records enabled reflective monitoring of the researcher's pedagogical decisions, implementation challenges, and student responses throughout the process [46,47]. The notes were also considered together with student views to support the holistic interpretation of qualitative findings and strengthen data triangulation.

2.5 Data Analysis

Quantitative data obtained from the implementations were analyzed using SPSS. First, means and standard deviations were calculated for pretest and posttest scores obtained from the ITS Literacy Scale and the Motivation toward the ITS Course Scale. Given the sample size, the Shapiro-Wilk test was used to assess the normality assumption for parametric analyses, and skewness and kurtosis coefficients were also examined. In the main implementation, the Shapiro-Wilk values for pretest and posttest scores on the Motivation toward the ITS Course Scale were $W = .913$, $p = .064$ and $W = .928$, $p = .126$, respectively. For the ITS Literacy Scale, the corresponding values were $W = .916$, $p = .074$ and $W = .936$, $p = .186$. All Shapiro-Wilk test results were above the .05 significance level, and the skewness and kurtosis coefficients were within acceptable limits. Based on these findings, the score distributions were considered sufficiently normal, and paired-samples t tests were used to examine changes between pretest and posttest measurements. To avoid relying solely on statistical significance, Cohen's d_z was calculated as an effect size, and the significance level was set at .05.

Qualitative data obtained from the focus group interviews were analyzed using content analysis. After the audio recordings were transcribed, the transcripts were read repeatedly, meaningful units of data were identified through open coding, and similar codes were grouped to form categories and themes. The resulting themes were organized to reflect students' experiences, perceptions, and affective responses regarding the AI-based instructional process, and the findings were supported with direct participant quotations. Researcher notes were incorporated into the analysis to contextualize the interview findings, explain situations observed during implementation, and identify similarities and differences across data sources.

To strengthen the credibility of the qualitative findings and the consistency of interpretations, member checking, researcher triangulation, transparent reporting of the analytical process, and the use of direct quotations were employed. As part of member checking, selected students were asked whether their statements had been accurately represented in the findings. The coding and theme-development process was also reviewed by a second researcher; disagreements regarding codes and themes were compared and discussed until consensus was reached. After the

quantitative and qualitative analyses had been completed independently, the findings were compared in accordance with the convergent parallel mixed-methods design, and convergent, complementary, and divergent results were interpreted together.

The researcher served as both the developer of the instructional design and the practitioner who conducted the classroom implementation. To reduce the risk of subjective interpretation associated with this dual role, the implementation followed pre-established lesson plans and the stages of the ASSURE Model. In addition, measurement instruments with established validity and reliability evidence, student views, and systematic researcher notes were used together to support data triangulation.

3. Results

This section first presents the revisions made to the instructional design based on evidence obtained from the pilot implementation. It then reports the quantitative findings regarding changes in students' ITS literacy and motivation toward the ITS course during the main implementation, followed by the qualitative findings derived from student views and the integration of the quantitative and qualitative findings.

3.1 Findings Related to the Development of the Instructional Design

Quantitative and qualitative data obtained during the pilot implementation were used together for the formative evaluation of the instructional design. This section reports only the findings that directly informed revisions to the design.

The AI-based instructional design developed in accordance with the ASSURE Model was structured by considering learner characteristics, levels of digital readiness, learning styles, and the objectives of the ITS course. The learner analysis indicated that students had limited experience with AI applications, experienced misconceptions when distinguishing AI tools from other digital platforms, and tended to use technology primarily for entertainment and content consumption. In contrast, students showed interest in hands-on, creative activities involving the development of tangible products. Based on these findings, the instructional process was designed to include experiential, practice-oriented, and collaborative activities, together with tasks involving the production of images, videos, audio, text documents, presentations, and spreadsheets.

A six-week pilot implementation was conducted to evaluate the feasibility of the instructional design in the classroom and identify areas requiring improvement. The pilot findings showed that students were interested in AI tools, developed a variety of digital products, and gradually began to write more explicit and detailed prompts as the weeks progressed. However, particularly during the early stages of the implementation, students required support with prompt writing, distinguishing the functions of different tools, using interfaces in foreign languages, technical access, and time management. Student views similarly highlighted difficulties related to internet connectivity, complex interfaces, time constraints, and the need for additional prompt examples.

Researcher notes showed that these needs varied across the implementation weeks. During the initial weeks, students experienced difficulties in constructing appropriate prompts and selecting tools according to their intended purposes. In later weeks, they were observed to produce more detailed prompts, revise their products, and support one another through group work. Nevertheless, technical difficulties and time-related problems in some activities were not completely eliminated throughout the implementation.

These findings from the pilot implementation were used to revise the instructional design in accordance with the Evaluate and Revise stage of the ASSURE Model. The most substantial revision was the addition of a two-week preparatory program before the six-week product-development phase of the main implementation. This program supported students' use of email and EBA, secure account management, registration and access procedures for AI tools, principles of safe and ethical use, and basic prompt-writing skills. In this way, technical and access-related procedures that had consumed a considerable portion of instructional time during the pilot phase were moved to the beginning of the instructional process, and the main implementation was restructured to last a total of eight weeks. The preparatory program was not treated as an independent intervention but as an integral preparatory component incorporated into the instructional design on the basis of the pilot findings.

Table 3 Revisions to the Instructional Design Based on Pilot Implementation Findings

Need Identified During the Pilot Implementation	Revision Made to the Instructional Design	Related ASSURE Stage
Students experienced difficulty constructing effective prompts.	Basic prompt-writing activities, analysis of sample prompts, and activities requiring students to revise prompts based on generated outputs were added to the preparatory program.	Analyze Learners; Utilize Media and Materials
Difficulties were encountered in email, EBA, and account management.	Activities involving secure email login and logout, creation of strong passwords, use of EBA, and online communication were incorporated.	Analyze Learners; Utilize Media and Materials
Registration and access procedures for AI tools reduced the amount of instructional time available.	Registration, login, and basic interface-use activities were moved to the preparatory program conducted before the main instructional activities.	Select Methods, Media, and Materials; Utilize Media and Materials
Students experienced difficulty distinguishing the functions of different tools.	Additional short examples, instructions, and hands-on demonstrations illustrating the purposes of the tools were incorporated.	Utilize Media and Materials

Need Identified During the Pilot Implementation	Revision Made to the Instructional Design	Related ASSURE Stage
Some groups were unable to complete activities within the planned time.	The sequence and duration of activities were revised, and group roles and task distributions were defined more explicitly.	Require Learner Participation; Evaluate and Revise
Technical problems and English-language interfaces made tool use more difficult.	Preventive technical checks, alternative access options, and teacher guidance when needed were incorporated into the instructional design.	Utilize Media and Materials; Evaluate and Revise

Following these revisions, the instructional design was finalized for the main implementation. In the revised structure, the two-week preparatory program was followed by a six-week implementation period focusing on the production of images, videos, audio/music, text documents, presentations, and spreadsheets. Thus, rather than serving as an independent phase for generating outcome evidence, the pilot implementation functioned as a formative evaluation process through which the instructional design was refined in response to learner needs and authentic classroom conditions.

3.2 Findings Related to ITS Literacy

A paired-samples *t* test was conducted to examine the difference between students' ITS literacy scores before and after the main implementation. The results are presented in Table 4.

Table 4 Pretest-Posttest Comparison of ITS Literacy Scores

Measurement	<i>n</i>	<i>M</i>	<i>SD</i>	<i>t</i>	<i>df</i>	<i>p</i>	Cohen's <i>d</i> <i>z</i>
Pretest	21	3.61	0.70	-2.669	20	.015	0.58
Posttest	21	4.19	0.65				

Note. *p* < .05.

As shown in Table 4, students' mean posttest ITS literacy score (*M* = 4.19, *SD* = 0.65) was higher than their mean pretest score (*M* = 3.61, *SD* = 0.70). The paired-samples *t* test indicated a statistically significant difference between the pretest and posttest scores, *t*(20) = -2.669, *p* = .015. The calculated Cohen's *d**z* of 0.58 indicated a medium effect size.

3.3 Findings Related to Motivation toward the ITS Course

A paired-samples *t* test was conducted to examine the difference between students' motivation toward the ITS course before and after the main implementation. The results are presented in Table 5.

Table 5 Pretest–Posttest Comparison of Motivation toward the ITS Course

Measurement	<i>n</i>	<i>M</i>	<i>SD</i>	<i>t</i>	<i>df</i>	<i>p</i>	Cohen's <i>dz</i>
Pretest	21	4.21	0.54	-4.059	20	.001	0.89
Posttest	21	4.72	0.18				

Note. $p < .05$.

As shown in Table 5, students' mean posttest motivation score ($M = 4.72$, $SD = 0.18$) was higher than their mean pretest score ($M = 4.21$, $SD = 0.54$). The paired-samples t test indicated a statistically significant difference between the pretest and posttest scores, $t(20) = -4.059$, $p = .001$. The calculated Cohen's dz of 0.89 indicated a large effect size.

3.4 Findings from Student Views

Students' views regarding the AI-based instructional design developed in accordance with the ASSURE Model were analyzed using content analysis. The analysis yielded five themes: overall experience and distinctiveness, impact on the learning process, motivation and interest, development of digital literacy, and feedback and improvement. The themes and corresponding codes are presented in Table 6.

Table 6. Themes and Codes Derived from Student Views

Theme	Codes
Overall experience and distinctiveness	Facilitating everyday life; conscious and appropriate use; understanding the image-generation process
Impact on the learning process	Recognizing the capabilities of AI; concerns about its effects on human labor and occupations; evaluations of its influence on art and production
Motivation and interest	Time savings and convenience; interaction/conversational features; increased interest in the course
Development of digital literacy	Learning and problem solving through questioning; multimedia production; support for research and homework
Feedback and improvement	Difficulty with prompt writing; English-language interfaces; desire to develop more advanced applications; overall satisfaction

3.4.1 Overall Experience and Distinctiveness

Students described the AI-based instructional process as a useful, production-oriented learning experience connected to everyday life. Participants particularly emphasized that AI facilitated homework and research processes, helped them better understand how visual content is generated, and enabled them to use AI more consciously.

For example, one student stated:

“Through this course, I learned to use AI properly rather than using it randomly.” (S2)

Another student explained:

“I no longer call everything I see AI. I can distinguish actual AI tools much better now.” (S6)

3.4.2 Impact on the Learning Process

Students reported that the implementation helped them gain a better understanding of the capabilities of AI while also prompting critical reflection on its potential effects on human labor and certain occupations. Concerns were particularly expressed regarding the future role of AI in areas such as art, writing, and customer service.

For example, one student stated:

“I think there is a negative side too, because sometimes it feels like it could take over people’s work.” (S1)

Another student explained:

“At first, we only knew the name of AI, but after trying it in the lessons, we understood much better how it actually works.” (S4)

3.4.3 Motivation and Interest

Students reported that AI tools increased their interest in the course, particularly because they facilitated the production process, provided rapid feedback, and offered an interactive experience. Participants also indicated that being able to begin tasks more easily and produce tangible outcomes within a relatively short time supported their motivation.

One student stated:

“When I get help from AI, I can finish things more quickly, and that motivates me more.” (S4)

Another student explained:

“When I get results quickly, I feel like ‘I can do this,’ and I become more enthusiastic about the course.” (S1)

3.4.4 Development of Digital Literacy

Students indicated that the instructional process broadened their use of technology from information consumption toward production and problem solving. They reported using AI tools as learning supports for preparing presentations, producing images and videos, conducting research, and finding solutions to problems they encountered.

For example, one student stated:

“When I get stuck and ask, ‘How can I do this?’, it shows me a way forward.” (S6)

Another student noted:

“Now we can create things like images and videos that fit the topic more easily.” (S7)

3.4.5 Feedback and Improvement

Although students’ overall views were positive, prompt-writing skills and the English-language interfaces of some AI tools emerged as areas requiring further support. Students also expressed an interest in progressing beyond simply using AI tools and eventually developing their own AI applications.

One student stated:

“I have a little difficulty writing prompts... But when I see an example, it becomes easier.” (S6)

Another student explained:

“I think we could develop an AI application ourselves too.” (S5)

3.5 Findings from Researcher Notes

Researcher notes were systematically examined throughout the implementation. Rather than being analyzed as a chronological record, recurring patterns across the process were identified. Five themes emerged: (i) digital readiness and technical adaptation, (ii) participation and collaboration in the learning process, (iii) development of prompt-writing skills, (iv) ethical awareness and critical evaluation, and (v) challenges encountered during the process. The findings related to these themes are presented below.

3.5.1 Digital Readiness and Technical Adaptation

Researcher notes indicated that the two-week preparatory program incorporated into the instructional design following the pilot implementation supported students’ digital readiness. By the end of the preparatory period, students were observed to perform email and EBA use, access AI tools, and complete basic login procedures more independently. This reduced the amount of time devoted to technical procedures during the main implementation and allowed more instructional time to be allocated to learning activities.

3.5.2 Participation and Collaboration in the Learning Process

Researcher notes showed that students became increasingly active in group work as the implementation progressed, organized task distribution more systematically, and demonstrated greater willingness to share their products with the class. Their efforts to review and improve initial drafts and make use of peer feedback further demonstrated active participation in the production process. This pattern was observed across the image, video, audio, text, presentation, and spreadsheet activities.

3.5.3 Development of Prompt-Writing Skills

Another prominent finding in the researcher notes was the gradual development of students' prompt-writing skills. At the beginning of the implementation, students tended to use short and ambiguous prompts. As the process progressed, they were observed to construct more detailed prompts, revise them after evaluating AI-generated outputs, and use the prompt-output-refinement cycle more deliberately. Nevertheless, some students continued to require limited support when constructing more detailed prompts for complex tasks.

3.5.4 Ethical Awareness and Critical Evaluation

Researcher notes indicated that students' awareness of ethical issues related to AI use became increasingly visible throughout the implementation. Across different weeks, students discussed the authenticity of images, copyright, misleading video and audio content, misinformation, source attribution, protection of personal data, and verification of AI-generated outputs. By the end of the process, students were observed to demonstrate greater awareness of the need to verify AI-generated content before using it.

3.5.5 Challenges Encountered During the Process

Researcher notes showed that some difficulties persisted throughout the implementation despite the preparatory program. These included constructing complex prompts, time management, English-language interfaces, the large number of formatting options available in some tools, and certain technical procedures. However, most of these difficulties appeared to decrease over time through teacher guidance, peer support, and strategies developed by students through repeated practice.

3.6 Integration of Quantitative and Qualitative Findings

In accordance with the convergent parallel mixed-methods design, the quantitative findings related to ITS literacy and motivation toward the ITS course were integrated with the qualitative findings obtained from student views and researcher notes. During the integration process, points of convergence, complementarity, and divergence across the data sources were examined. A joint display of the quantitative and qualitative findings is presented in Table 7.

Table 7 Joint Display of Quantitative and Qualitative Findings

Dimension Examined	Quantitative Findings	Student Views	Researcher Notes	Integrated Interpretation
ITS literacy	Posttest ITS literacy scores	Students reported	Progress was observed over time	The data sources converged in

Dimension Examined	Quantitative Findings	Student Views	Researcher Notes	Integrated Interpretation
	were significantly higher than pretest scores.	improvement in conducting research, preparing presentations, producing images and videos, learning by asking questions, and problem solving.	in students' digital product creation, prompt writing, evaluation of AI-generated outputs, revision, and refinement behaviors.	showing a relationship between the quantitative increase in ITS literacy and students' experiences involving production, revision, evaluation, and problem solving.
Motivation toward the ITS course	Posttest motivation scores were significantly higher than pretest scores.	Students stated that AI made it easier to begin tasks, saved time, increased their curiosity, and enhanced their interest in the course.	Students were observed to participate actively in activities, assume responsibility during group work, show willingness to share their products, and experience a sense of accomplishment during product development.	The quantitative motivation findings were supported by qualitative evidence related to easier task initiation, rapid production of tangible outcomes, interaction, peer sharing, and perceived accomplishment.
Preparation and guidance supporting implementation	The effect of the preparatory program was not assessed through an independent quantitative measure.	Students reported that they had begun to use AI tools more accurately, consciously, and practically.	The two-week preparatory period was observed to reduce account and access problems and to support EBA use, safe practices, and basic prompt-writing skills.	The qualitative findings indicated that pre-implementation preparation and ongoing teacher guidance were important conditions supporting the feasibility of the instructional design.

Dimension Examined	Quantitative Findings	Student Views	Researcher Notes	Integrated Interpretation
Conscious, safe, and critical use	The quantitative measures did not directly assess ethical awareness as a separate variable.	Students reflected on misinformation, personal data, human labor, and the potential effects of AI on art and occupations.	Authenticity, copyright, misleading visual, video, and audio content, source attribution, protection of personal data, and verification of AI-generated outputs were discussed throughout the implementation.	The qualitative findings showed that, alongside technical skills, awareness related to questioning AI-generated outputs and using AI safely also emerged during the instructional process.
Persistent challenges	Quantitative findings reflected overall changes but did not provide detailed information about implementation difficulties experienced by individual students.	Students reported difficulties in constructing prompts, expressing their ideas clearly, and using English-language interfaces.	Some students continued to require support with output refinement, managing multiple options, time management, text verification, and completing technical procedures.	Despite the positive quantitative findings, the need for sample prompts, gradual scaffolding, tools with Turkish-language interfaces, and teacher guidance did not disappear entirely.

As shown in Table 7, the quantitative and qualitative findings largely converged with respect to ITS literacy and motivation toward the ITS course. The significant increase in ITS literacy scores was consistent with students' reported experiences of conducting research, developing multimedia products, constructing prompts, evaluating AI-generated outputs, and refining their products. While students indicated that AI tools supported research, presentation preparation, image and video production, and problem solving, the researcher notes similarly showed that, as the implementation progressed, students increasingly evaluated, revised, and refined initial AI-generated outputs rather than using them without modification.

Similarly, the significant increase in motivation toward the ITS course was supported by students' reports that they were able to begin tasks more easily, produce tangible products within a relatively short time, receive rapid feedback, and experience greater interest in the course. Researcher notes further indicated that students participated actively in group work, were willing to share their products, and experienced a sense of accomplishment during the production process. These findings indicate consistency

between the quantitative motivation results and the qualitative evidence concerning students' learning experiences.

In addition to supporting the quantitative findings, the qualitative data revealed processes that were not directly captured by the quantitative measures. The two-week preparatory activities conducted before the main implementation were observed to support students' email and EBA use, access to AI tools, safe use, and basic prompt-writing skills, thereby reducing the amount of instructional time devoted to technical procedures during the main implementation. However, because the effect of the preparatory program was not examined through an independent quantitative measure, it should be interpreted not as a separate effect variable but as a condition that supported the implementation of the instructional design.

Student views and researcher notes also showed that the instructional process extended beyond technical skill development. Students reflected on misinformation, personal data, human labor, and the potential effects of AI on art and occupations, while issues such as authenticity, copyright, misleading content, source attribution, and verification of AI-generated outputs were discussed throughout the implementation. Because the quantitative instruments did not measure ethical awareness as a separate construct, these findings were interpreted as a complementary dimension of the instructional process that became visible through the qualitative data.

At the same time, the data sources indicated that the implementation did not proceed equally smoothly for all students. Some students continued to require support in structuring prompts clearly, expressing their ideas in writing, using English-language interfaces, choosing among alternatives, managing time, and verifying outputs. Taken together, the integrated findings suggest that the quantitative improvements observed following the instructional design should be interpreted within a broader instructional context that included pre-implementation preparation, product-oriented activities, iterative output refinement, peer interaction, teacher guidance, and ethical discussion.

4. Discussion

The findings suggest that the pedagogical value of AI in the ITS course may depend less on the mere use of AI tools than on their integration within a systematic instructional design that brings together learner characteristics, instructional objectives, student participation, production and refinement processes, teacher guidance, and ethical-critical evaluation. Accordingly, the findings are discussed in terms of the development and implementation of the instructional design, observed changes in ITS literacy and motivation, students' learning experiences, and the conceptual and practical implications of the study.

4.1 Development and Implementation of the ASSURE Model-Based AI Instructional Design

In this study, AI was not treated as a technology topic separate from the ITS course, but as an instructional component aligned with course objectives, learner

characteristics, production tasks, and assessment processes. Students developed a range of digital products, including images, videos, audio, text documents, presentations, and spreadsheets, while engaging in a recurring cycle of prompt construction, output evaluation, revision, and product refinement. In this way, AI integration was embedded within the core learning activities of the course. This approach is consistent with studies demonstrating how AI can be incorporated into the pedagogical structure of existing subject areas. Park et al. [48], for example, integrated AI content with existing science concepts, while Kayafoğlu [49] emphasized the importance of systematic instructional design when aligning AI-based activities with the objectives of different school subjects.

A central function of the ASSURE Model in this process was to prevent AI tools from being used in an ad hoc manner by establishing pedagogical coherence among learner analysis, objective setting, selection of methods, media, and materials, learner participation, and evaluation. Similarly, Erdoğan and Çakır [28] integrated AI into lesson planning, activity development, and assessment while preservice teachers developed AI-supported instructional materials in accordance with the ASSURE Model. Cai et al. [27] likewise demonstrated that AI and digital resources can be integrated with the learner analysis, media selection, learner participation, and evaluation stages of ASSURE, while Jang and Jung [29] showed that AI can serve as a structured learning support in art production and analysis. Jeon [50] further reported that integrating AI tools into instruction through the ASSURE Model supported rapid drafting and option generation while maintaining the importance of instructor guidance and human feedback. Taken together, these studies and the present findings suggest that the ASSURE Model can provide a practical framework for moving AI integration beyond tool use toward systematic instructional design.

An important feature of the present study was the formative role of the pilot implementation in refining the instructional design. Difficulties identified during the pilot phase in account access, tool interfaces, prompt construction, and time management led to the inclusion of a two-week preparatory period before the main implementation. The fact that technical procedures became more manageable during the main implementation and that a larger proportion of instructional time could be devoted to production and refinement activities highlights the importance of revising instructional designs on the basis of implementation data. This finding is consistent with Kayafoğlu's [49] emphasis on flexibility and adaptability in AI-based instructional design and with Kosmas et al. [51], who reported that co-design processes with teachers can support implementation feasibility.

Teacher modeling, group roles, and peer feedback also served as important components supporting learner participation. Students were not expected to accept the first AI-generated output uncritically; rather, they were required to evaluate outputs against their intended purposes, redirect the AI when necessary, and further develop their products. This approach was important for retaining students' responsibility for decision making rather than transferring that responsibility to AI. Torres-Peña et al. [52]

similarly noted that although AI tools can provide rapid and personalized feedback, they do not always identify student errors accurately, while Jeon [50] emphasized the continuing need for teacher guidance because of the contextual and linguistic limitations of AI-generated outputs. These findings help explain why output verification, revision, and teacher guidance were treated as ongoing components of the instructional design in the present study.

Ethical use was also addressed as an integral part of students' production tasks rather than as a separate topic. Issues such as copyright, human labor, misinformation, personal data, synthetic images and audio, and disclosure of AI assistance were discussed in relation to the products being developed. Students were therefore expected not only to use AI tools technically but also to question the accuracy, safety, and appropriateness of AI-generated outputs. Choi et al. [53], who examined AI ethics education through a systematic instructional design, similarly emphasized that ethical awareness should not be separated from technical competence.

Overall, the principal instructional-design contribution of this study lies not in the use of specific AI tools but in the integration of learner analysis, preparation, production, iterative refinement, teacher guidance, collaboration, and ethical evaluation within the ASSURE Model. The findings suggest that simply introducing AI into the classroom may not in itself generate pedagogical value; rather, such value appears to be related to the learning objectives for which AI is used, the learning actions in which students are engaged, and the assessment processes through which its use is structured. In this sense, the study provides a classroom-based example of integrating AI into the ITS course through an instructional-design-centered rather than technology-centered approach.

4.2 Discussion of Findings Related to Information Technologies and Software Literacy

Following the main implementation, students' ITS literacy scores increased significantly, with a medium effect size. Student views and researcher notes also indicated that experiences involving digital product creation, evaluation of AI-generated outputs, product revision, and technical problem solving were consistent with this quantitative change. It is important to emphasize that the variable measured in this study was ITS literacy rather than AI literacy. The observed change should therefore be interpreted in relation to broader ITS competencies, including digital content creation, evaluation of information and data, use of different applications, problem solving, and safe and purposeful technology use. This conceptualization is consistent with DigComp 2.2, which includes information and data literacy, digital content creation, safety, and problem solving [11]. Similarly, ICILS 2023 conceptualizes computer and information literacy in terms of accessing and evaluating digital information, producing information digitally, and participating responsibly [7,54]. From this perspective, ITS literacy in the present study represents a broader domain of digital competence than the ability to operate a particular AI tool.

The production- and refinement-oriented structure of the instructional process is particularly important for interpreting the observed quantitative change. While developing digital products such as images, videos, audio, text, presentations, and spreadsheets, students defined purposes, constructed prompts, evaluated outputs, and revised their products. This structure enabled technology to be used not only for consuming ready-made content but also for creating, revising, and solving problems. Gökçe and Nacaroglu [55] similarly reported increases in digital literacy following AI-focused instruction at the middle school level. Xu et al. [56] also showed that an AI-supported learning environment in an information technology curriculum could be associated with positive outcomes in academic performance and problem-solving tendencies. These findings suggest that AI-supported activities may provide a meaningful learning context when they are explicitly connected to production and problem-solving processes.

The prompt-output-evaluation-refinement cycle used throughout the instructional process required students to compare, identify errors in, and revise AI-generated outputs rather than accepting the first output directly. Students verified texts, restructured presentations, and checked AI-suggested formulas in spreadsheets, thereby retaining responsibility for judgment and evaluation. This finding is consistent with studies indicating that digital literacy extends beyond technical operational competence. Hsu and Hughes [57] reported that middle school students' digital literacy can develop in technology-rich and project-based learning environments, while Colwell et al. [58] showed that information access and evaluation skills require structured instructional support. Hatlevik et al. [59] identified a significant relationship between ICT self-efficacy and computer and information literacy, and Lei et al. [60] demonstrated a positive association between ICT literacy and academic achievement at the meta-analytic level.

At the same time, the use of AI should not be assumed to improve digital literacy automatically or across all dimensions. Naamati-Schneider and Alt [61] found that ChatGPT-supported problem-based learning was associated with improvement particularly in evaluation skills, while comparable development was not observed in access and analysis dimensions. This suggests that the critical issue is not simply whether an AI tool is used, but how students are engaged in active thinking and critical evaluation. Similarly, Lyu and Salam [62] reported positive outcomes related to digital literacy in AI-supported personalized learning, while Yim [63] found that production-oriented and interdisciplinary AI activities could support conceptual understanding in areas such as data, ethics, and computational thinking. Wu and Zhang [64] also identified a positive relationship between generative AI use and digital literacy. Considered together, these studies suggest that the increase observed in the present study may be associated less with AI use itself than with its use within structured ITS tasks involving production, verification, revision, and teacher guidance.

The qualitative findings further support this interpretation. Students reported moving beyond viewing technology merely as a means of consuming ready-made content and

increasingly using it to create images, videos, presentations, and other digital products, learn by asking questions, and seek solutions to problems. Researcher notes likewise indicated that students gradually developed more explicit prompts, evaluated initial outputs, and refined their products more independently. However, some students continued to require support with English-language interfaces, complex prompts, and time management, suggesting that familiarity with digital technologies should not be equated with advanced digital literacy. This observation is consistent with studies emphasizing that familiarity with digital technologies alone does not constitute advanced digital literacy [65,66].

Overall, the increase observed in ITS literacy scores was consistent with qualitative findings indicating a shift from content consumption toward production and from accepting initial outputs toward questioning and refinement. These findings should be interpreted in the context of an instructional process that combined preparatory training, diverse digital production tasks, iterative refinement, teacher and peer support, and checks related to accuracy, safety, and ethics. Accordingly, the potential value of AI integration in the ITS course appears to derive not merely from introducing new tools but from providing students with opportunities to engage in research, production, revision, data work, verification, and responsible technology use.

4.3 Discussion of Findings Related to Motivation toward the ITS Course

Following the main implementation, students' motivation toward the ITS course increased significantly, with a large effect size. Student views and researcher notes provided convergent evidence regarding interest in the course, task initiation, active participation, product creation, and a sense of accomplishment. This change should not be interpreted solely in terms of the novelty of AI tools but in relation to a learning environment in which students were able to make choices, develop tangible products, observe their progress, and share their work with peers. From the perspective of Self-Determination Theory, this structure can be interpreted in terms of autonomy through choice, competence through successful product development, and relatedness through group work and product sharing [18].

The qualitative findings showed that students experienced AI as a form of learning support that saved time, facilitated task initiation, provided rapid feedback, and supported product development. These findings are consistent with Bişirici [67], Demir [22], and Gündoğdu [24], who reported increases in motivation in AI-based instructional applications. Internationally, Yang et al. [68] found that a generative AI-based information technology instructional model supported students' learning motivation and satisfaction, Moybeka et al. [69] identified a significant relationship between AI use and learning motivation, and Al-Barghouthi [70] reported that an AI-based application could positively affect motivation among sixth-grade students independently of achievement.

However, AI use does not appear to increase motivation in all circumstances. Yucal [26] reported an increase in academic achievement in AI-supported social studies instruction but no significant difference in motivation, while Holman [71] found that AI-

supported personalized learning did not provide a clear advantage over traditional instruction in terms of situational interest. Such differences suggest that changes in motivation may depend less on the technology itself than on pedagogical characteristics such as the appropriateness of activities for students, the active role assigned to learners, feedback, product development, and teacher guidance.

Overall, the increase in motivation should not be interpreted as evidence that AI is inherently motivating. Rather, the findings suggest that a process structured around rapid feedback, product variety, student choice, collaborative work, iterative refinement, and teacher guidance may have supported students' interest and participation in the ITS course. The motivational value of AI therefore appears to depend less on its novelty than on whether it is used to position students as active, productive, and responsible participants in the learning process.

4.4 Students' Learning Experiences and the Productive, Critical, and Ethical Use of AI

Student views and researcher notes indicated that the implementation provided an engaging and production-oriented learning experience. Students did not merely obtain rapid content from AI; they developed products across multiple media formats, revised outputs, made decisions within groups, and restructured their work according to specific purposes and target audiences. In this way, technology use expanded from ready-made content consumption toward digital production.

The progress observed in prompt writing suggests that students increasingly recognized the importance of their own decisions regarding purpose, context, format, and target audience in shaping AI-generated outputs. Defining these elements more explicitly and then comparing the resulting outputs with their expectations moved prompt writing beyond a purely technical act of issuing commands. The process involved cognitive and metacognitive operations such as planning, explicit articulation, evaluation, and revision. Given that overreliance on AI support may weaken student agency, it remains important that responsibility for questioning and transforming outputs stays with the learner [72].

Students' efforts to verify the accuracy of texts, assess the appropriateness of images, evaluate the quality of presentations, and check the functionality of AI-suggested formulas provide concrete examples of how critical use became visible within implementation tasks. Rather than assuming that AI-generated outputs were accurate and ready for use, students were expected to evaluate them in terms of purpose, accuracy, and appropriateness. Findings reported by Güler [73] and Yıldızhan Bora and Şahin Kölemen [30] likewise suggest that AI-based production can support interest, creativity, and technical learning, while also requiring teacher guidance and quality control because of inaccurate outputs, passive use, prompt-writing challenges, and access difficulties.

Embedding ethical issues across different production tasks rather than restricting them to a single lesson allowed students to consider these issues through concrete decisions about technology use. Copyright and human labor, misleading images and audio, personal data, misinformation, and disclosure of AI assistance were addressed while relevant products were being developed. This approach is consistent with international guidance advocating age-appropriate, safe, human-centered, and pedagogically supervised use of generative AI [14]. However, because ethical awareness was not assessed through an independent measurement instrument, these findings should be interpreted only in relation to indicators of awareness emerging from student views and researcher notes.

Challenges involving technical access, account management, different interfaces, and limited device availability further demonstrated that AI integration depends not only on pedagogical design but also on technological conditions. Although the preparatory process and group roles reduced the impact of these difficulties, age-appropriate tool selection, data security, infrastructure, and technical support need to be planned in advance. Overall, the findings suggest that students' relationship with technology can become more productive and critical, but that this development depends less on access to AI itself than on teacher guidance, output verification, iterative product development, and ethical reasoning.

4.5 Conceptual and Practical Implications

A key contribution of this study to instructional design and educational practice is its treatment of AI integration in terms of the quality of instructional design rather than the use of specific tools. AI was not introduced as a technology topic separate from the ITS course; instead, it was structured as an instructional component supporting the development of visual, video, audio, text, presentation, and data-based products. In this respect, the findings support perspectives arguing that the educational value of AI derives not from the technical characteristics of tools themselves but from their pedagogical alignment with learning objectives, student readiness, active participation, teacher guidance, and assessment processes [14,72,74].

A further contribution is the classroom-based evidence suggesting that the ASSURE Model can provide a feasible framework for structuring AI-based instruction at the middle school level. Whereas AI-based materials and instructional designs grounded in ASSURE have largely been examined with preservice teachers or in higher education contexts [28,30], the present study adapted the model directly to the learning experiences of sixth-grade students. International studies have also applied the learner analysis, media and material selection, learner participation, and evaluation stages of ASSURE in AI-supported language, art, and translation education [27,29,50]. The revision of the instructional design following the pilot implementation further demonstrates how the evaluation and revision dimension of ASSURE can be operationalized in AI integration.

A central practical implication concerns the importance of supporting students' digital readiness before beginning AI-based instruction. The preparatory process involving account management, secure access, protection of personal data, and basic prompt-writing skills helped reduce technical and conceptual barriers that could otherwise interfere with AI activities. This finding suggests that teachers should consider not only which AI tools to use but also the extent to which students are prepared to work with those tools.

The study also provides a practical example of how student agency can be maintained in AI-supported learning. Students were expected not to accept the first AI-generated output but to compare it with their intended purposes, verify it, revise it, and explain their improvement decisions. Group roles and peer feedback also helped prevent participation from being restricted to the student directly operating the device in settings with limited technological resources. AI was thus positioned not as a system that produces work on behalf of students, but as a tool supporting students' planning, production, and evaluation processes.

Embedding ethical use across different production tasks represents another practical contribution of the study. Copyright, human labor, misinformation, personal data, synthetic images and audio, and disclosure of AI assistance were addressed not as abstract rules but through decisions directly related to students' own products. This approach highlights the importance of developing technical competence together with critical evaluation, safe use, and ethical responsibility in AI education [14].

Overall, the distinctive value of the study lies not in the use of particular AI tools but in the instructional design integrating preparation, production, iterative refinement, collaboration, teacher guidance, and ethical inquiry. This structure demonstrates how AI can be integrated into a middle school ITS course through an instructional-design-centered approach that preserves student participation and responsibility rather than through a technology-centered approach.

Limitations and Future Research

The study was conducted in a single public middle school with a limited number of sixth-grade students and within the scope of specific ITS learning objectives. Accordingly, the findings should not be directly generalized to different school types, grade levels, or technological infrastructures. The accessibility, language support, and technical stability of the AI tools used may also have influenced the implementation process. The researcher's role in developing and implementing the instructional design and maintaining researcher notes should likewise be considered when interpreting the findings.

The researcher also served as the classroom teacher who implemented the instruction, maintained the researcher notes, and moderated the focus group interview. This dual role may have influenced both the interpretation of classroom observations and the ways in which students expressed their views. In particular, students may have been

less inclined to provide critical evaluations or may have emphasized positive experiences when participating in interviews conducted by their teacher.

The one-group pretest-posttest design did not allow the observed changes to be compared with those resulting from an alternative instructional approach. However, the aim of the study was not primarily to compare instructional methods, but to examine the implementation of the developed instructional design and the changes observed during this process through multiple data sources. Future research should evaluate the design with different student populations and teachers, larger samples, follow-up measurements, and comparative research designs. Systematic analysis of student products, prompt revisions, screen recordings, and performance rubrics may also provide a more detailed account of how learning develops throughout AI-supported instructional processes.

Conclusion

Following the main implementation, significant increases were observed in students' ITS literacy and motivation toward the ITS course. Student views and researcher notes further indicated experiences of production, output refinement, verification, collaboration, and ethical questioning that were consistent with these quantitative changes. Taken together, the findings suggest that the ASSURE Model-based AI instructional design provided a feasible and educationally promising learning structure in an authentic classroom setting.

These findings should not be interpreted as evidence that AI alone improves learning. Rather, the observed changes were associated with a holistic instructional structure comprising preparatory training, production tasks aligned with course objectives, iterative prompt and product development, teacher guidance, peer feedback, and ethical evaluation. The educational value of AI in the ITS course therefore appears to depend less on its capacity to generate ready-made content than on how it is structured to engage students in goal setting, production, questioning, and responsible decision making.

Accordingly, AI integration at the middle school level should include prior support for students' technical and digital readiness, treat AI-generated outputs as initial drafts to be evaluated and refined rather than finished products, and incorporate verification, improvement, and ethical evaluation into each production task.

Author contributions

M.A.Ö. contributed to the conceptualization of the study, development of the instructional design, data collection, data analysis, interpretation of the findings, and preparation of the original manuscript draft. H.Ş. contributed to the conceptualization and methodological development of the study, provided guidance throughout the research process, contributed to the interpretation of the findings, and critically reviewed and revised the manuscript. Both authors read and approved the final manuscript.

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Data Availability

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This study was approved by the Akdeniz University Social Sciences and Humanities Scientific Research and Publication Ethics Committee on November 12, 2024 (Decision No. 474; Document No. 1058466). All methods involving human participants were performed in accordance with the principles of the Declaration of Helsinki and the Directive on the Ethics of Scientific Research and Publication for Higher Education Institutions in Türkiye, as well as applicable institutional ethical standards and regulations. Written informed consent was obtained from the parents or legal guardians of all participating students, and voluntary assent was obtained from the students prior to participation. Separate permission for audio recording of the focus group interviews was obtained from both the parents or legal guardians and the participating students.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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