An Intelligent Conversational Agent Based on Adaptive Learning to Enhance Learning Design Competencies of Pre-service Teachers

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***Abstract*—This study aimed to (1) develop an intelligent conversational agent informed by adaptive learning principles; and (2) assess the impact of the agent's utilisation on the improvement of instructional design skills. A Research and Development (R&D) approach was employed. The participants consisted of 50 third-year undergraduates from the Bachelor of Education program at Suan Dusit University, chosen via cluster sampling. The research instruments included an intelligent conversational agent developed using a LINE Chatbot integrated with generative Artificial Intelligence (AI) technology (EdCafe AI), an instrument quality evaluation form, a knowledge test and instructional design skills assessment, and a satisfaction questionnaire. Data were analysed using descriptive statistics and a dependent t-test, and instrument reliability was examined using Cronbach's alpha. The results indicated that the developed system comprised two main components: a front-end interface using the LINE Chatbot "LUWIGA" to facilitate learner access and a back-end processing system on the EdCafe AI platform supporting adaptive learning through natural language processing, automated feedback, document and image analysis, and instructional design support. Learning content was additionally linked through the Canva platform to ensure alignment with learning objectives. Expert evaluation showed that the overall quality of the tool was at its highest level. Students' post-test knowledge achievement was significantly higher than their pre-test scores at the 0.01 level, instructional design skills were rated at a high level, and learner satisfaction was at the highest level. These findings suggest that integrating AI chatbots with adaptive learning principles can effectively support personalised learning and instructional design development.**

***Keywords*—artificial intelligence in education, intelligent conversational agent, adaptive learning, learning design, pre-service teacher**

I. Introduction

The accelerating pace of digital and societal transformation in the twenty-first century has introduced substantial challenges for contemporary educational systems, particularly in relation to preparing learners with the competencies required for future life and employment [1]. In this context, the preparation of pre-service teachers-who serve as a key driving force in the development of future generations-has become critically important. Of particular significance is the development of instructional design skills that are responsive to rapidly-changing social and technological environments. Instructional design that aligns with the learning characteristics and expectations of today's learners represents a central foundation for pre-service teachers as they transition toward professional teaching practice. Rather than focusing solely on content delivery, effective instructional design must intentionally integrate future-orientated competencies, including analytical thinking for problem-solving, creativity, and the meaningful application of digital technologies [2]. Consequently, pre-service teachers are required to develop the capacity to design learning experiences that accommodate individual learners' needs across content, pedagogical approaches, and technology-enhanced learning environments. This viewpoint aligns with the national education reform agenda set forth by the Ministry of Education, which emphasises the necessity of enhancing teachers' capacities to implement active learning methodologies and to strategically utilise digital technologies as essential elements of teaching and learning processes [3]. Enhancing instructional design skills constitutes a foundational component of professional teacher competence. As future educators who will have an important influence on the nation's youth, pre-service teachers must be systematically prepared in ways that align with ongoing social, technological, and educational transformations characteristic of the twenty-first century [4].

In the contemporary educational landscape, Artificial Intelligence (AI) technologies have assumed an increasingly prominent role, and have gained widespread adoption as powerful tools for strengthening learning effectiveness. AI has particular potential to address learners' diverse needs and individual differences in a responsive and scalable manner [5]. This pedagogical orientation is closely aligned with the principles of adaptive learning, which emphasise the design of learning environments that accommodate individual variability in prior knowledge, abilities, and learning preferences. By tailoring learning experiences to the unique characteristics of each learner, adaptive learning approaches contribute to the holistic enhancement of learning quality and support more equitable and meaningful educational outcomes [6]. Adaptive learning has gained increasing scholarly attention over the past decade as an instructional approach that leverages technology to tailor learning content, processes, and pedagogical strategies to learners' individual abilities and learning preferences [7]. In this context, the development of intelligent conversational agents to support adaptive learning for pre-service teachers offers significant potential. Such tools can facilitate individuals' understanding of core learning concepts and instructional design principles while dynamically responding to learners' interests and learning needs through personalised interaction [8]. This perspective is consistent with a growing

body of research, indicating that intelligent conversational agents contribute to increased learner motivation, engagement, and overall learning effectiveness, particularly in higher education and teacher education contexts [9]. For example, previous studies have reported on competency assessment systems for pre-service teachers operating in virtual environments, where intelligent tools are used to analyse performance and provide targeted feedback prior to teaching practicum experiences. These systems support deeper learning through immediate reflective feedback, enabling pre-service teachers to refine their instructional competencies before entering real classroom settings [10].

Furthermore, contemporary AI technologies demonstrate strong potential for delivering highly-personalised learning experiences. Through advanced language-based learning mechanisms that adapt to user behaviour, AI systems are capable of contextual analysis, dynamic content adjustments, and conversational modulation aligned with learners' characteristics and interests. These capabilities allow learning interactions to be continuously refined in ways that are both pedagogically-appropriate and individually meaningful [11]. Although there is a relatively large body of research focusing on AI-aided learning tools and intelligent conversational agents for higher education, several research questions remain unanswered. First, the majority of previous studies have primarily focused on satisfaction and short-term learning performance rather than on systematic efforts to develop pre-service teachers' instructional design competencies. Second, few studies have explicitly integrated adaptive learning principles with intelligent conversational agents to provide personalised scaffolding for instructional design activities. Third, teacher education research in Southeast Asia examining the use of AI-based conversational systems to enhance instructional design skills is relatively scarce. To address these gaps, this study aims to develop and evaluate a responsive conversational agent that incorporates adaptive learning mechanisms to assist pre-service teachers in enhancing their instructional design capabilities for learning within an authentic university context.

II. Literature Review

The search and selection of literature for this review were conducted using international academic databases such as Scopus, Web of Science, and Google Scholar. Priority was given to published, peer-reviewed journal articles from 2019–2025 so as to capture the latest advancements in adaptive learning, Intelligent Conversational Agents (ICAs), generative AI, and learning design competencies. The keywords used in the search included adaptive learning, intelligent conversational agent, AI chatbot in education, learning design, and pre-service teacher education.

A. Adaptive Learning

Adaptive learning refers to an instructional approach designed to be flexible and responsive, enabling learning content, instructional methods, and learning pathways to be dynamically adjusted to meet individual learners' specific needs. This approach relies on in-depth analysis of learners' interests, levels of understanding, and learning behaviours through the application of AI technologies and data analytics systems [12]. Its theoretical foundations can be traced to personalised learning principles and the constructivist learning theory of Jerome Bruner (1915–2016), a cognitive psychologist and educational theorist who emphasised active learner engagement and knowledge discovery as central mechanisms of effective learning [13]. Adaptive learning functions as a pedagogical technique that enhances learning experiences by aligning them with individual learner characteristics. It enables the continuous monitoring of learner-related data such as learning progress, engagement levels, and academic performance, which can then be utilised to design personalised learning experiences [14]. In practice, adaptive learning uses technologies that change the level and type of curricular content based on how well students are doing, and how their skills are improving. Such mechanisms contribute to improved learning efficiency by providing both automated and instructor-mediated guidance tailored to individual learners' needs [15]. In summary, adaptive learning represents an approach that leverages digital technologies to personalise learning experiences based on learners' interests, preferences, and learning readiness. Through adaptive content delivery, structured guidance, content summaries, and timely feedback, learners are supported in developing understanding, revisiting learning materials without temporal or spatial constraints, and engaging in learning processes that align closely with their individual needs. These characteristics foster deeper learning, enhance retention, and lead to more effective learning outcomes. Empirical evidence supporting the effectiveness of adaptive learning can be found in the study by Victor *et al.* [16], who developed and evaluated an AI- and data analytics–driven adaptive learning web application to enhance Computer-Aided Design (CAD) skills among engineering students. Seven hundred and eight students enrolled in the Graphic Expression course at Universitat Politècnica de Catalunya (UPC), Spain, participated in the study. The findings demonstrated that students who learnt through the adaptive system achieved significantly higher academic performance than those in traditional learning environments, and reported high levels of satisfaction. The system employed the K-Nearest Neighbors (KNN) algorithm to analyse learning behaviours and adjust learning activities and difficulty levels in real time. As a result, learners experienced reduced learning-related stress, improved conceptual understanding of CAD, and narrowing achievement gaps among students with diverse prior knowledge, highlighting the effectiveness of AI-supported adaptive learning in delivering personalised educational experiences [16].

B. Principles of Learning Design

Effective teaching and learning require systematic planning and instructional design. Lesson plans therefore serve as essential tools that enable teachers to organise learning activities with clear directions and achieve predetermined instructional goals [17]. Instructional design plays a critical role for teachers at all educational levels and can be likened to a compass that guides the teaching-learning process, supporting the effective implementation of learning activities [18]. Consequently, the development of high-quality lesson plans necessitates a deep understanding of the school curriculum, allowing teachers to design instruction that is focused, coherent, and aligned with intended learning objectives [19]. This perspective is consistent with Gravett and van der Merwe [20], who

emphasise that effective instructional design should account for a diversity of teaching approaches and the strategic application of pedagogical techniques to ensure that learning goals are achieved. They further highlight the importance of systematic lesson preparation, with particular attention being paid to the coherent sequencing of learning activities from beginning to end. Similarly, Børte and Lillejord [21] describe lesson planning as an integral component of the instructional system, involving advance preparation based on curriculum requirements and instructional processes. The planning process involves setting goals, choosing content, and creating activities. It also includes selecting and using appropriate teaching materials to achieve the desired learning outcomes, which are shown by how well students perform, before the lesson is taught in class. In summary, lesson plans function as a fundamental instructional framework that guide teachers in organising learning activities to support student success. Lesson planning is a methodical way for teachers to make sure that the content of the curriculum, the methods of teaching, the goals of learning, and the ways of testing all work together to make teaching and learning more effective. Empirical support for the role of AI in lesson planning is provided by Baytak [22], who examined the use of ChatGPT and Google Gemini in designing lesson plans at the lower secondary level. The study analysed 18 AI-generated lesson plans and found that both systems could produce relatively comprehensive instructional plans. ChatGPT demonstrated strengths in structuring learning activities systematically, whereas Gemini placed greater emphasis on addressing learner diversity. Most of the lesson plans reflected constructivist principles and positioned the teacher as a facilitator of learning. However, limitations were identified in terms of technology integration and the design of in-depth assessment methods. The findings suggest that while chatbots hold considerable potential as instructional support tools, teachers' professional judgement and competencies in AI use and prompt design remain essential to ensuring high-quality instructional design and effective learning outcomes.

C. Intelligent Conversational Agent Tools

Intelligent conversational agent tools are computer-based systems that communicate with users in natural language, either spoken or written, and are designed for public health research. These systems can provide information, help solve problems, and assist with tasks based on user requests or questions [23]. Commonly referred to by various terms such as chatbots, virtual assistants, or conversational agents, these technologies have undergone rapid development recently. Their evolution can be traced from simple rule-based systems that operated according to predefined rules to more advanced intelligent systems capable of learning and adaptation through machine learning techniques [24, 25]. In line with this progression, Singh and Namin [26] explain that conversational agent technologies initially relied on rule-based chatbot architectures but have since advanced toward AI-driven chatbots that leverage machine learning and deep learning techniques. Examples of such systems include ChatGPT, Google Dialogflow, Microsoft Bot Framework, and IBM Watson Assistant. These technologies are widely deployed across multiple applications, including automated messaging services, website-based question answering, and mobile application-based advisory systems accessible through various digital devices [26]. More recent developments have given rise to Artificial Intelligence agents (AI agents), which represent a new generation of autonomous systems powered by Large Language Models (LLMs). These agents possess capabilities for environmental perception, data analysis, decision-making, and autonomous action to achieve predefined objectives [27]. This change shows that AI-supported services are moving away from reactive interactions and towards more proactive and goal-oriented ones. Empirical evidence further supports the educational potential of intelligent conversational agents. Studies by Thanarat *et al.* [28] and Chanthakham and Kunnatruang [29], which examined the design and development of AI chatbot–based educational platforms, reported that the developed chatbots demonstrated very high performance in responding to learners' questions. After using the systems, learners showed a significant increase in perceived knowledge and understanding as a result of the personalised recommendations provided by the chatbots, which led to the highest level of overall user satisfaction. In summary, intelligent conversational agent tools represent advanced technologies capable of engaging in natural human–computer interaction through text, voice, or other interactive modalities across diverse platforms. Equipped with natural language processing capabilities and adaptive service features, these systems can be customised to align with contextual and individual user needs. As such, intelligent conversational agents serve as valuable tools for providing guidance, feedback, and timely responses, making them particularly well-suited for supporting learning and responding to learners' enquiries in educational settings.

D. Research Gap and Theoretical Positioning

According to the literature review, it is evident that, although adaptive learning systems and intelligent conversational agents have been shown to be effective tools for enhancing personalised learning, their application in training pre-service teachers in learning design remains underexplored. Specifically, limited research has examined how conversational AI can play a role as an adaptive scaffolding tool to support iterative instructional design processes, such as defining learning objectives, aligning activity and assessment, and integrating instructional media. Moreover, few empirical studies have investigated the use of such systems in teacher education programmes within Southeast Asian contexts. The current study addresses this gap by implementing an adaptive learning-based intelligent conversational agent and providing initial empirical evidence of its potential to enhance the development of pre-service teachers' learning design competencies.

Fig. 1 presents the conceptual framework of the study, showing the integration of intelligent conversational agent tools, adaptive learning, and learning design principles in developing an adaptive learning–based intelligent conversational agent. The framework illustrates how these components collectively support the enhancement of learning design skills among 21st-century pre-service teachers. The outcomes of this implementation are reflected in three dimensions: the effectiveness of the intelligent conversational agent, the development of knowledge and skills in learning design, and learners' qualitative satisfaction with its use.

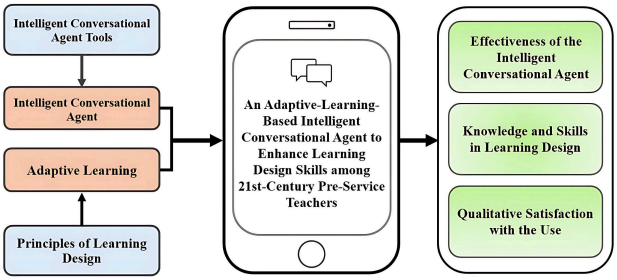

Fig. 1. Conceptual framework of the study.

III. METHODOLOGY

A. Population and Samples

The population of this study consisted of 790 undergraduates enrolled in the Bachelor of Education programme at the Faculty of Education, Suan Dusit University. The sample comprised 50 third-year students majoring in elementary education, selected through cluster sampling. The participants were drawn from nine class sections registered in the course Curriculum and Learning Management Sciences, the course content of which was aligned with the implementation of the research instrument. All selected participants had previously completed a course on Innovation and Digital Technology for Creative Learning and demonstrated readiness to use digital devices for accessing online systems. They possessed internet-connected devices, voluntarily agreed to participate in the research project, and provided informed consent for data collection for research purposes.

B. Research Instrument

The research instruments consisted of tools used for the experimental implementation, and instruments used for data collection as detailed below:

(1) Intelligent Conversational Agent (LUWIGA): The intelligent conversational agent, LUWIGA, served as the primary experimental tool. It was developed through the integration of the LINE Chatbot platform as the front-end interface with the EdCafe AI platform as the back-end processing system. The tool is capable of analysing user enquiries, providing guidance on lesson plan development, and adapting learning content based on learners' interests. In addition, LUWIGA can respond to questions and offer context-sensitive recommendations through interactive conversational exchanges.

(2) Tool Quality Evaluation and User Satisfaction Questionnaires: These instruments were employed for data collection and comprised evaluation items across five dimensions: (1) system design and structural organisation, (2) adaptive learning functionality, (3) content quality and support for instructional design skill development, (4) intelligent system performance, and (5) usability and user experience.

(3) Knowledge Test and Instructional Design Skills Assessment: These instruments were used to assess learning outcomes. The knowledge test consisted of 20 multiple-choice items with four response options, measuring participants' knowledge of instructional design principles. The instructional design skills assessment employed a performance-based rating checklist with five levels of proficiency across 10 items, based on participants' lesson plan designs or instructional planning outputs. The knowledge test was a standardised assessment aligned with course requirements, while the instructional design skills assessment was a standard rubric routinely used by the Faculty of Education, Suan Dusit University, to evaluate the instructional design competencies of pre-service teachers during their professional practicum experiences.

C. Data Collection

Data collection was conducted in two phases as follows.

(1) Phase 1 centred on expert assessment and validation of instrument quality, thereby establishing the suitability and dependability of the intelligent conversational agent and its related research instruments before the primary implementation. During this phase, five specialists, possessing expertise in education, educational technology, and educational measurement and evaluation, evaluated the content validity of the tool effectiveness and user satisfaction questionnaires. The Index of Item-Objective Congruence (IOC) was employed to determine the degree of alignment between the evaluation items and the research objectives. Furthermore, to assess reliability, the instruments underwent pilot testing with a cohort of 30 pre-service teachers, who were not part of the main sample, over a three-week duration. The initial implementation sought to assess system functionality, responsiveness to user interactions, and overall operational efficacy. Collected data facilitated an analysis of the evaluation instruments' reliability across five key dimensions: system design and structure, adaptive learning capabilities, content quality, instructional design skill support, intelligent system performance, usability, and user experience; reliability coefficients were computed using Cronbach's alpha. Subsequently, the intelligent conversational agent underwent an expert quality evaluation conducted by eleven specialists. These experts, each possessing a minimum of three years of professional experience in education, educational technology, or the application of artificial intelligence in educational contexts, assessed the system. A structured quality assessment form was employed to ensure the system's appropriateness for instructional design skill development.

(2) Phase 2 involved experimental implementation and data collection, during which the intelligent conversational agent (LUWIGA) was deployed in an authentic educational setting over a six-week period. A one-group pretest–posttest design was employed to examine changes in participants' instructional design knowledge, while a one-shot case design was used to evaluate instructional design skills. Throughout the intervention, participants used LUWIGA to study course content and received guidance on instructional design tasks, including defining learning objectives, designing learning activities, selecting instructional media, and planning assessment strategies. The system supported learners in developing a foundational understanding of lesson plan structure and in designing key instructional components, such as writing behavioural learning objectives, organising learning activities across lesson phases (introduction, learning

activities, and conclusion), selecting appropriate instructional media, and determining assessment and evaluation methods aligned with intended learning outcomes.

The experimental designs employed in this phase are presented in Table 1. Knowledge achievement was assessed using a one-group pretest–posttest design, while instructional design skills were evaluated using a one-shot case design.

Table 1. Experimental designs for knowledge and skills assessment

Design Type	Pretest	Treatment	Posttest
Knowledge assessment	K1	X	K2
Skills assessment	-	X	SP

Note:
X = Treatment using the intelligent conversational agent for instructional design learning
K1 = Knowledge pretest administered prior to the use of the intelligent conversational agent
K2 = Knowledge posttest administered after the use of the intelligent conversational agent
SP = Posttest assessment of instructional design skills after using the intelligent conversational agent

The experimental implementation was conducted over a six-week period. Throughout the intervention, the researcher monitored system usage to ensure consistent participation among the experimental group on a weekly basis. The procedures were carried out as follows:

Week 1: Orientation and Pretest: An orientation session was conducted for all 50 participants to provide a clear understanding of the research objectives, procedures, system usage guidelines, learning format, and participation agreements. Following the orientation, participants completed a pretest consisting of 20 multiple-choice items to assess their baseline knowledge of instructional design prior to using the intelligent conversational agent.

Week 2: Introduction to Lesson Plan Structure: Participants utilised the intelligent conversational agent to cultivate a fundamental understanding of lesson plan structure and essential components via self-directed learning. At the end of the session, participants summarised the learning outcomes they derived from the tool by creating either an infographic or a mind map.

Week 3: Designing Core Instructional Components: Participants engaged with the intelligent conversational agent to support the design of essential lesson plan components, including the formulation of behavioural learning objectives, learning activities, and the development of assessment methods aligned with instructional objectives. At the end of the session, participants synthesised their learning outcomes and practiced aligning objectives, activities, and assessment strategies in a cohesive manner.

Week 4: Designing Learning Activities and Instructional Media: During this week, participants used the intelligent conversational agent to design comprehensive learning experiences by developing lesson content and learning activities across the three main instructional phases: lesson introduction, core learning activities, and lesson conclusion. In addition, participants were guided to select and align appropriate instructional media for each phase of the lesson in accordance with the intended learning objectives. At the end of the session, participants synthesised their learning outcomes by refining their activity designs and instructional media selections based on the specific topics or content areas assigned by the researcher.

Week 5: Developing a Complete Lesson Plan: Participants used the intelligent conversational agent to develop a comprehensive lesson plan based on their individual interests. At the end of the session, participants reflected on their learning outcomes and finalised a comprehensive lesson plan aligned with the topics or content specified by the researcher.

Week 6: Refinement, Posttest, and Qualitative Data Collection: In the final week, participants used the intelligent conversational agent to refine and finalise their lesson plans. The completed lesson plans were submitted for post-intervention skill assessment, and the researcher evaluated them using the instructional design skills assessment rubric. Participants then completed a posttest to measure knowledge gains and responded to a satisfaction questionnaire regarding their use of the intelligent conversational agent.

At the end of the session, the researcher purposively selected 10 participants representing diverse usage patterns—such as frequent users who posed in-depth, inquiry-based questions; less frequent users who engaged in surface-level questioning; and participants with varying performance levels—for semi-structured interviews. The purpose of these interviews was to gather qualitative data on how well participants understood the instructional content, how they thought the tool helped them learn, their experiences using the tool, the problems they ran into, and their suggestions for how to improve the tool in the future.

D. Data Analysis

Quantitative data analysis included the results of expert evaluations of the tool quality, participants' qualitative satisfaction ratings, and pretest and posttest scores. The data were analysed using descriptive statistics, including Mean (M) and Standard Deviation (SD). Knowledge achievement before and after the intervention was compared using a dependent t-test. In addition, the reliability of the evaluation instruments was examined using Cronbach's alpha coefficient.

E. Ethical Considerations

All procedures performed in studies involving human participants were conducted in accordance with the ethical standards of the relevant institutional or national research committee. The research was conducted following ethical approval from the Subcommittee for Human Research Ethics in Science, Humanities, and Social Sciences, Research and Development Institute, Suan Dusit University (Approval No. SDU-RDI-SHS 2024-059). Participation was voluntary, and informed consent was obtained from all participants prior to data collection. Anonymity and the confidentiality of personal information were ensured by assigning numerical codes to participants throughout all stages of the study.

IV. Results

A. Development of the Intelligent Conversational Agent

The developed intelligent conversational agent comprises two integrated core components that function collaboratively: (1) a front-end interface and (2) a back-end processing system. The front-end interface employs a LINE Chatbot named LUWIGA as the primary communication

channel, enabling easy learner access through adding the chatbot as a LINE contact. This interface includes four main menus that connect users to different system functions: Live Chat, Pre-test, Post-test, and Content. The Live Chat, Pre-test, and Post-test menus are directly linked to the core back-end processing system of the EdCafe AI platform, which supports interactive dialogue and assessment delivery. This back-end system is the main engine for the smart chat tool, which can understand and respond to language, give personalised feedback, understand documents and images, help with teaching design, and answer questions interactively. The Content menu connects to the Canva platform, facilitating the presentation and summarisation of essential learning concepts. This feature facilitates learners in effortlessly locating comprehensive, accurate, and topic-specific instructional content that aligns with the course objectives and themes. The major components of the back-end processing system supporting the intelligent conversational agent are described as follows:

(1) User Welcome and Login System: The system incorporates a structured welcome and login function to record user data and facilitate an organised and efficient start to system usage.

(2) Generative AI Conversation Engine: The intelligent conversational system is capable of initiating greetings and engaging in dialogue that closely resembles human interaction in terms of intent recognition, question focus, and contextual understanding. It also demonstrates the capacity to provide expert-level responses. Key functional capabilities include:

(a) Natural Language Processing (NLP): The system interprets textual input through advanced natural language processing, enabling it to analyse linguistic meaning and respond appropriately to the user's intent and context. The system can dynamically adjust conversations into English or other languages in a fluent and grammatically-accurate manner.

(b) Adaptive Feedback and Explanation: The system provides adaptive explanations and feedback based on learners' interest levels and proficiency. For example, it can deliver simplified explanations with basic examples for novice learners, while offering more detailed guidance for advanced users.

(c) Document and Image Understanding: The system is capable of processing information from document files (e.g., .pdf, .docx), image files (e.g., .jpg, .png), and other text-based formats. The uploaded materials are automatically analysed, with key points summed up in an accessible format. The system can further elaborate on meanings, structural elements, or underlying concepts based on user requests.

(d) Instructional Design and Lesson Planning Support: The system supports the design of lesson plans in accordance with commonly-accepted educational standards. This includes defining learning objectives, designing learning activities aligned with learner characteristics, selecting appropriate instructional media and learning resources, and specifying assessment and evaluation methods that align with expected learning outcomes.

(e) Context-Aware Interactive Dialogue: The system supports continuous and context-sensitive interaction, enabling it to respond accurately to a wide range of user enquiries. By analysing user intent and situational needs in real time, the system can deliver relevant answers, recommendations, and guidance efficiently and appropriately, thereby supporting learners' instructional design processes effectively.

Fig. 2 illustrates the general Intelligent Conversational Agent System Architecture, based on the previously described system units. The design of this architecture explains how the UI, generative AI conversation engine, adaptive learning and back-end processing modules interact with each other to assist instructional design & personalisation.

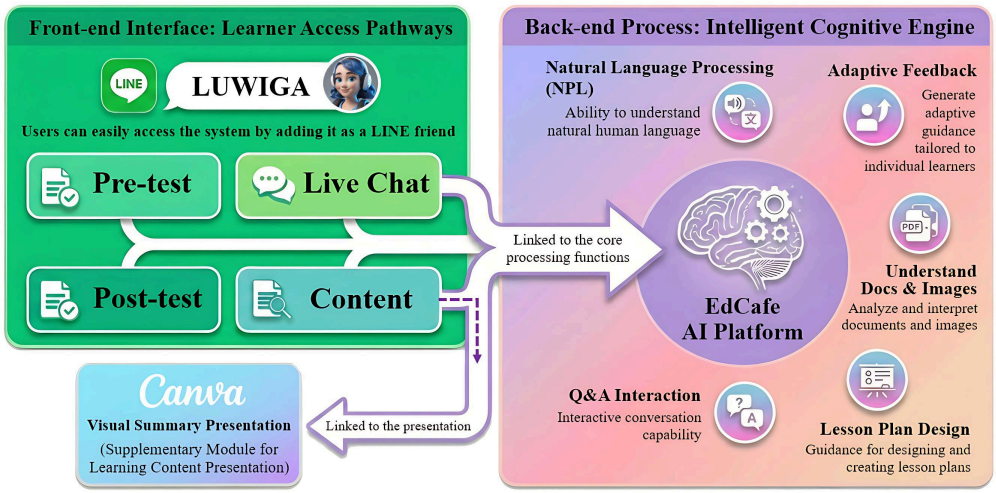

Fig. 2. Intelligent conversational agent system architecture.

B. *Results of the Quality Evaluation of the Intelligent Conversational Agent*

Evaluation Results of the Intelligent Conversational Agent: The results of the quality and appropriateness evaluation conducted by 11 experts in education, educational technology, and the application of AI in education are presented in Table 2.

As shown in Table 2, the intelligent conversational agent demonstrated a very high level of quality across all dimensions, with an overall mean score of M = 4.75, S.D. = 0.43. When the mean scores were ranked from highest to lowest, the highest-rated dimension was intelligent system

performance (M = 4.82, S.D. = 0.39), followed by content quality and instructional design skill enhancement (M = 4.80, S.D. = 0.41). The dimensions of adaptive learning and usability and user experience received equal mean scores (M = 4.73, S.D. = 0.45), while system design and structure showed a slightly lower but still highest mean score (M = 4.70, S.D. = 0.46). At the item level, the highest mean score (M = 4.91, S.D. = 0.30) was observed for several evaluation items including (1) content alignment with 21st-century skills such as problem-solving, creativity, and technology use; (2) applicability of content to real-world instructional design contexts; (3) the system's ability to respond to questions in a logical and reasonable manner; (4) accurate understanding of diverse question formats; (5) natural and context-appropriate dialogue; and (6) ease of initial system use. These findings indicate that the intelligent conversational agent developed is highly effective and well aligned with the need to enhance instructional design skills.

Table 2. Results of the quality evaluation of the intelligent conversational agent (n = 11)

Evaluation Items	M	S.D.	Quality Level
1. System Design and Structure			
1.1 The system layout and interface design are well-organized and user-friendly	4.82	0.40	Highest
1.2 Fonts, colours, and presentation formats are readable and appropriate	4.73	0.47	Highest
1.3 Menus and system navigation are clear and not complex	4.55	0.52	Highest
1.4 The system supports multiple devices (Responsive Web) such as smartphones, tablets, and computers	4.73	0.47	Highest
Mean (System Design and Structure)	4.70	0.46	Highest
2. Adaptive Learning 2.1 The system can adapt content and explanations to learners' interests and needs	4.82	0.40	Highest
2.2 The system can adjust dialogue style, language, and communication level to suit learners	4.55	0.52	Highest
2.3 The system supports understanding of key instructional design components and provides guidance that extends learning	4.73	0.47	Highest
2.4 The system effectively supports learning differences among individuals	4.82	0.40	Highest
Mean (Adaptive Learning)	4.73	0.45	Highest
3. Content Quality and Instructional Design Skill Enhancement 3.1 Recommended content related to instructional design is accurate and aligned with the research objectives	4.82	0.40	Highest
3.2 Recommended content enhances analytical thinking and technology integration skills	4.55	0.52	Highest
3.3 Recommended content is connected to 21st-century skills such as problem-solving, creativity, and technology use	4.91	0.30	Highest
3.4 Recommended content can be applied to real-world instructional design contexts	4.91	0.30	Highest
Mean (Content Quality and Skill Enhancement)	4.80	0.41	Highest
4. Intelligent System Performance			
4.1 The system responds to questions in a logical and reasonable manner	4.91	0.30	Highest
4.2 The system understands diverse question formats and provides accurate responses	4.91	0.30	Highest
4.3 The system responds promptly and processes queries in real time	4.55	0.52	Highest
4.4 System dialogue is natural and aligned with learning contexts	4.91	0.30	Highest
Mean (Intelligent System Performance)	4.82	0.39	Highest
5. Usability and User Experience			
5.1 The system is easy to use without requiring advanced technological skills	4.91	0.30	Highest
5.2 The system stimulates interest and enhances learning motivation	4.55	0.52	Highest
5.3 The system supports learners' self-regulated learning	4.73	0.47	Highest
5.4 The system provides an overall experience conducive to adaptive learning and active learning	4.73	0.47	Highest
Mean (Usability and User Experience)	4.73	0.45	Highest
Overall Mean (All Dimensions)	**4.75**	**0.43**	**Highest**

C. *Results of the Quality Verification of Data Collection Instruments*

The content validity of the intelligent conversational agent evaluation tool was examined using the Index of Item-Objective Congruence (IOC). The results showed a high level of content validity, with an IOC value of 0.92. In addition, the reliability of the instrument was assessed using Cronbach's alpha coefficient. The overall reliability value was 0.86 (86%), indicating satisfactory reliability.

D. *Comparison of Mean Knowledge Achievement Scores*

The comparison of mean knowledge scores in instructional design for the sample of 50 participants before and after the intervention is presented in Table 3.

Table 3. Comparison of knowledge achievement scores before and after the intervention (n = 50)

Knowledge Test	M	S.D.	t	d	df	Sig. (2-tailed)
Pretest Mean Score	10.60	2.04	30.31	3.54	49	0.00**
Posttest Mean Score	16.94	1.50				

** $p < 0.01$ (The difference is statistically significant at the 0.01 level, two-tailed).

As shown in Table 3, there was a statistically significant increase from pre-intervention to post-intervention for participants' knowledge achievement scores. We found the mean posttest score (M = 16.94, S.D. = 1.50) to be significantly greater than the average pretest score (M = 10.60, S.D. = 2.04). The difference was found to be statistically significant at the 0.01 level (t = 30.31, df = 49, $p < 0.01$). To determine the magnitude of this increase is, we computed Cohen's d, a measure of this effect (d = 3.54). The result indicates that the learning gains are not only statistically significant but also practically meaningful for this research.

E. *Results of the Instructional Design Skills Assessment (Lesson Plan Writing)*

Table 4 presents the mean scores of the sample group's instructional design skills after the learning intervention.

As shown in Table 4, the overall instructional design skills of the sample group (n = 50) were rated at a high level (M = 4.36, S.D. = 0.61). When examined at the item level, six items were rated highest. Ranked from highest to lowest mean scores, these included: designing lesson plans with

complete core components (M = 4.60, S.D. = 0.49); designing learning activities that emphasize learner participation and promote 21st-century learning skills (M = 4.56, S.D. = 0.61); formulating learning objectives that comprehensively address knowledge, skills, and attitudes (M = 4.52, S.D. = 0.50); designing engaging learning activities at each instructional stage that align with the specified learning objectives (M = 4.52, S.D. = 0.61); writing behavioural learning objectives with clearly measurable behaviours (M = 4.50, S.D. = 0.58); and selecting instructional content appropriate to the allocated instructional time (M = 4.50, S.D. = 0.58), respectively. In contrast, the two items with the lowest mean scores were related to instructional media selection, namely selecting instructional media appropriate to learners' levels and creatively integrating digital technologies (M = 4.12, S.D. = 0.59) and selecting diverse, up-to-date, and engaging instructional media aligned with learning objectives, content, and instructional activities (M = 4.12, S.D. = 0.52), respectively.

Table 4. Results of the instructional design skills assessment (n = 50)

Instructional Design Skill Assessment Items	M	S.D.	Skill Level
1. Designing lesson plans with complete core components	4.60	0.49	Highest
2. Formulating learning objectives that cover knowledge, skills, and attitudes (K–P–A)	4.52	0.50	Highest
3. Writing behavioural learning objectives with clearly measurable behaviours	4.50	0.58	Highest
4. Selecting instructional content appropriate to the allocated time	4.50	0.58	Highest
5. Designing engaging learning activities aligned with the specified learning objectives	4.52	0.61	Highest
6. Designing learning activities that promote learner engagement and 21st-century skills	4.56	0.61	Highest
7. Writing lesson plans using formal and clear academic language	3.94	0.51	High
8. Selecting diverse, up-to-date, and engaging instructional media aligned with objectives, content, and activities	4.12	0.52	High
9. Selecting instructional media appropriate to learners' levels and creatively integrating digital technologies	4.12	0.59	High
10. Designing assessment methods aligned with learning objectives and instructional activities	4.22	0.65	High
Overall Mean	**4.36**	**0.61**	**High**

F. *Results of the Satisfaction Evaluation*

Table 5 presents the mean scores of the sample group's satisfaction with the use of the intelligent conversational agent after the learning intervention.

Table 5. Results of the satisfaction evaluation (n = 50)

Evaluation Items	M	S.D.	Satisfaction Level
1. System Design and Structure 1.1 The system layout and interface design are well-organized and user-friendly	4.56	0.67	Highest
1.2 Fonts, colours, and presentation formats are readable and appropriate	4.58	0.54	Highest
1.3 Menus and system navigation are clear and not complex	4.54	0.61	Highest
1.4 The system supports multiple devices (Responsive Web) such as smartphones, tablets, and computers	4.62	0.53	Highest
Mean (System Design and Structure)	4.58	0.59	Highest
2. Adaptive Learning 2.1 The system can adapt content and explanations to learners' interests and needs	4.64	0.53	Highest
2.2 The system can adjust dialogue style, language, and communication level to suit learners	4.56	0.54	Highest
2.3 The system supports understanding of key instructional design components and provides guidance that extends learning	4.62	0.49	Highest
2.4 The system effectively supports learning differences among individuals	4.58	0.57	Highest
Mean (Adaptive Learning)	4.60	0.53	Highest
3. Content Quality and Instructional Design Skill Enhancement 3.1 Recommended content related to instructional design is accurate and aligned with the research objectives	4.66	0.48	Highest
3.2 Recommended content enhances analytical thinking and technology integration skills	4.50	0.58	Highest
3.3 Recommended content is connected to 21st-century skills such as problem-solving, creativity, and technology use	4.58	0.57	Highest
3.4 Recommended content can be applied to real-world instructional design contexts	4.64	0.57	Highest
Mean (Content Quality and Skill Enhancement)	4.60	0.53	Highest
4. Intelligent System Performance 4.1 The system responds to questions in a logical and reasonable manner	4.70	0.51	Highest
4.2 The system understands diverse question formats and provides accurate responses	4.68	0.51	Highest
4.3 The system responds promptly and processes queries in real time	4.52	0.61	Highest
4.4 System dialogue is natural and aligned with learning contexts	4.68	0.47	Highest
Mean (Intelligent System Performance)	4.65	0.53	Highest
5. Usability and User Experience 5.1 The system is easy to use without requiring advanced technological skills	4.72	0.50	Highest
5.2 The system stimulates interest and enhances learning motivation	4.50	0.65	Highest
5.3 The system supports learners' self-regulated learning	4.54	0.61	Highest
5.4 The system provides an overall experience conducive to adaptive learning and active learning	4.56	0.58	Highest
Mean (Usability and User Experience)	4.58	0.59	Highest
Overall Mean (All Dimensions)	**4.60**	**0.55**	**Highest**

As shown in Table 5, the qualitative satisfaction evaluation of the intelligent conversational agent for instructional design, based on responses from 50 participants, revealed that the overall level of satisfaction was at the highest level (M = 4.60, S.D. = 0.55). When analysed by dimension, all aspects were rated at the highest level. Among these, intelligent system performance received the highest mean score (M = 4.65, S.D. = 0.53). Adaptive learning and content quality and instructional design skill enhancement followed, both sharing the same mean score (M = 4.60, S.D. = 0.53).

The dimensions of system design and structure, as well as usability and user experience, also demonstrated similarly high levels of satisfaction ($M = 4.58$, S.D. = 0.59). At the item level, the highest-rated aspects were the ease of initial system use without requiring advanced technological skills ($M = 4.72$, S.D. = 0.50), the system's ability to respond to questions in a logical and reasonable manner ($M = 4.70$, S.D. = 0.51), and the naturalness and contextual appropriateness of system dialogue, together with its ability to accurately understand and respond to diverse question formats ($M = 4.68$, S.D. = 0.47–0.51). Overall, these findings indicate that the developed intelligent conversational agent is user-friendly, well-structured, and effective in supporting learners' instructional design skill development.

V. Discussion

The results of the expert evaluation revealed that the intelligent conversational agent demonstrated a very high level of quality across all dimensions, with the highest mean score observed in the dimension of intelligent system performance. This finding shows that the tool's design and development—combining generative AI through the EdCafe AI platform with a LINE Chatbot interface—met learners' needs for accurate content, clear explanations, and adaptive interaction that fit their contexts. The consistently very high ratings reflect strong acceptance of generative artificial intelligence as a suitable and effective technology for educational applications, particularly in terms of logical responses, understanding diverse question formats, and generating natural dialogue. These findings are consistent with the perspectives of Reda [25] and Singh and Namin [26], who emphasised the critical role of artificial intelligence and machine learning in transforming learning processes to better respond to individual learners' needs and support adaptive learning environments. Furthermore, the results align with studies by Thanarat *et al.* [28] and Chanthakham and Kunnatruang [29], which reported that AI chatbot–based educational platforms achieved very high quality in terms of content and media, significantly enhanced users' perceived usefulness of chatbot-generated recommendations, and yielded the highest levels of overall user satisfaction. Collectively, these findings support the view that AI chatbots can function as valuable learning support tools with meaningful educational benefits.

These results should be interpreted within the context of the study's design limitations. The use of a one-group pretest–posttest experimental design in this study does not rule out the potential threats to internal validity, such as maturation and testing effects. Thus, our findings should be regarded as tentative working hypotheses rather than definitive evidence of treatment efficacy. Further studies employing stronger controls and comparative designs are required to establish more robust causal inferences. LUWIGA offers learning support aligned with adaptive learning strategies and constructionist approaches. While natural language processing can facilitate learning by tailoring scaffolding to learner's needs, adaptive feedback operates in a way that promotes learner independence, enabling learners to become aware of their own learning by dynamically adjusting explanations according to their competence levels [30]. Moreover, this context-based interaction encourages students to actively construct knowledge rather than engage in passive learning, and the conversational agent is conceptualised as a pedagogical aid that functions not only as an information provider but also as a cognitive partner supporting learners' thinking processes [12, 31].

With regard to learning outcomes, the use of the intelligent conversational agent significantly enhanced both knowledge and instructional design skills among the sample group. The posttest knowledge scores were significantly higher than pretest scores, and overall instructional design skills were rated at a high level, with most pre-service teachers demonstrating performance at a satisfactory to very satisfactory level. These results suggest that the tool effectively supports the development of essential practical skills for pre-service teachers. This effectiveness can be attributed to key system features, particularly real-time feedback and step-by-step explanations, which help learners construct understanding in a structured and systematic manner. These findings are consistent with prior studies by Deng and Yu [32] and Victor *et al*. [16], who reported that the use of chatbots in educational settings positively influenced learning achievement and explicit reasoning, enabling learners to develop more profound understanding and retain knowledge more effectively, while also stimulating learning interest—even if direct effects on motivation or engagement were not always evident [16, 30]. Overall, these studies concluded that chatbots exert a moderate to high positive impact on learning outcomes, particularly in terms of learning achievement. In addition, the present study found that most participants were able to design lesson plans at a high level, demonstrating competencies in academic language use, selection of diverse instructional media, and alignment of assessment methods with learning objectives and activities. These findings are consistent with Baytak [22], who reported that AI tools such as ChatGPT and Gemini can effectively support pre-service teachers in lesson planning while emphasising the continued need for human oversight to ensure alignment with educational standards and learning theories. In this regard, the LUWIGA intelligent conversational agent may be conceptualised as an academic mentor that supports pre-service teachers' instructional development within the framework of the Zone of Proximal Teacher Development (ZPTD). This interpretation aligns with Gao [31], who found that applying ZPTD principles in combination with scaffolding from peers and instructors effectively supports the progression of pre-service teachers from foundational to professional levels of instructional competence.

Regarding user satisfaction, the findings indicated that participants reported the highest level of satisfaction across all dimensions, particularly in terms of intelligent system performance, adaptive learning, and content quality. These results reflect the effectiveness of system design in addressing learners' expectations and needs. The findings are consistent with Chaiprasurt *et al.* [33], who reported high satisfaction with chatbot use in blended learning environments. Qualitative feedback further highlighted the importance of usability, logical interaction, and natural dialogue, emphasising the key role of effective User Interface (UI) and User Experience (UX) design in fostering

acceptance and sustained use of educational technologies. This perspective is supported by Buraphadeja and Chantokul [34], who stress that user-friendly chatbot design is a key factor influencing system adoption and perceived value in blended learning contexts. Moreover, qualitative analysis revealed that learners particularly valued three key aspects: (1) convenience and accessibility consistent with ubiquitous learning principles, (2) content quality that clarified instructional design concepts, and (3) the presence of a personalised assistant that fostered confidence and psychological safety. These findings align with Gransden *et al.* [12], who highlighted the role of AI in adaptive learning environments that provide real-time personalisation and promote learners' psychological safety. Similarly, Victor *et al.* [16] demonstrated that AI-driven adaptive learning systems can enhance learning achievement, reduce learning-related stress, and narrow gaps among learners with diverse backgrounds. Overall, the findings of this study are consistent with McGuire's [30] adaptive learning framework, which emphasises aligning instructional methods, content, and time with individual learner characteristics to achieve learning goals more effectively. Taken together, the results indicate that the LUWIGA intelligent conversational agent has a strong potential to support learning and professional development in teacher education through systematic, adaptive, and learner-centred instructional support.

VI. Conclusion

This study examined the development and implementation of an adaptive learning–based intelligent conversational agent designed to enhance pre-service teachers' instructional design competencies within a university context. The overall findings provide initial empirical evidence regarding the educational potential of AI-supported adaptive learning systems in teacher education. This finding suggests that an adaptive and intelligent conversational agent is a potential tool to support Pre-Service Teachers (PSTs) to learn how to design lessons more effectively. While the findings present encouraging results, they should be considered within the exploratory nature of an R&D study. The findings add to the growing body of evidence on AI-enhanced teacher education; they indicate that conversational agents can act as adaptive learning companions rather than substitutes for teachers. This research suggests that an adaptive-learning intelligent conversational agent can support PSTs in developing their learning design competencies. By integrating adaptive learning principles within the AI-based generative conversational system, LUWIGA acted not only as an information-sharing tool but also as a smart learning partner, providing continuous assistance whenever design choices were revised, personalised feedback, and support for planning future lessons in response to contextual needs. The system design demonstrates the effective implementation of conversational AI for complex educational tasks, achieved through the integration of a user-friendly front-end chatbot interface and a powerful back-end AI processing platform.

The results indicated that the intelligent conversational agent received the highest recommendation ratings from experts, significantly enhanced users' knowledge following post-exposure, and facilitated pre-service teachers in acquiring advanced instructional design skills. Additionally, learners reported a high level of satisfaction, raising the question of whether adaptive and personalised interaction is a key factor in maximum learning benefits from AI-based learning tools. These findings further support the study's conceptualization that adaptive learning intelligent conversational agents can be used as effective personalised learning assistants, serving as bridges between theory, practice, and the diverse needs of teacher learners in teacher education. Moreover, the proposed system design and implementation plans were validated as beneficial from both engineering and educational technology perspectives and can serve as a foundation for developing future AI-based learning support systems.

Nevertheless, factors such as the absence of a control group and the limited sample size constrain the current study. Future research should employ more rigorous research designs to enable a deeper understanding of the long-term effects of intelligent conversational agents on learning gains. Future research should also investigate learning analytics-driven adaptive mechanisms and how data-informed personalisation can better support pedagogical decision-making. It would also be informative to investigate the extent to which intelligent conversational agents can actually support teaching across different educational contexts and subject areas. Subsequent research may explore the integration of gamification between learning and assessment phases to enhance learner motivation and engagement.

In addition to empirical and technical implications, the results from this study raise significant pedagogical issues and ethical considerations regarding the use of artificial intelligence in teacher education. Intelligent conversational agents should be conceptualised as learning assistants or instructional aids rather than replacements for teachers. While AI can deliver personalised feedback and guidance, the teacher's role remains essential for fostering professional judgment, ethical reasoning, critical thinking, and socio-emotional competencies, which are difficult to automate. Teacher education programmes should therefore explicitly address the ethical responsibilities associated with AI use. Pre-service teachers also require support in developing AI literacy, particularly with regard to potential risks such as overreliance on AI-generated content, algorithmic bias, and the unintentional dissemination of misinformation. Furthermore, educational institutions should establish clear policies and guidelines governing the use of AI in teaching and research, including issues of transparency in AI-assisted work and appropriate scholarly attribution. Incorporating these ethical and professional considerations into AI-enabled learning activities may help pre-service teachers become responsible future users and developers of AI technologies.

Conflict of Interest

The authors declare no conflict of interest.

Author Contribution

S.C.: Conceptualization; Methodology; Research design; Development of the intelligent conversational agent;

Software development and technical validation; Construction of the instructional design framework; Coordination and submission for human research ethics approval; Writing-original draft preparation; writing-review and editing; integration of all research components. A.Ko.: Literature review; instrument development and validation; system implementation and technical support; data coordination and analysis support; graphic design; preparation of figures and layout design; writing, review, and editing; and formatting and proofreading. A.Kh.: Monitoring of the experimental procedures; Interpretation of system performance outcomes; Review of international and English-language literature to ensure theoretical alignment and global relevance; Academic language refinement and stylistic editing of the manuscript. P.P. (Corresponding Author): Supervision; Methodological and theoretical guidance; Critical manuscript revision; Validation of research findings; Project administration; coordination among co-authors and journal communication; final approval of the manuscript. All authors had approved the final version.

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