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Developing and validating an AI-supported teaching applications' self-efficacy scale

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Abstract

Applying AI-supported technology improves teachers' digital capabilities and optimises students' independent learning. This study used a questionnaire to construct and verify a teacher's AI-supported teaching application self-efficacy (AIS-TASE) measurement that examined reliability and validity and explored the relationship between teachers' AIS-TASE and behaviour. The AIS-TASE scale includes five constructs: self-affirmation, passion for teaching, adherence to hard work, negative consciousness, and positive belief. There were 1456 senior and vocational high school teachers from 45 schools. The measurement analysis results indicated that the scale has reliability, validity, and the scale can be used as a measurement for teachers to judge themselves in AI-supported teaching. The result indicated teachers' AIS-TASE and behaviour towards background variables. It is found that when teachers use technology-instruction integration AI experience, teachers' perception of using AI-supported technology in school and having a positive attitude towards AI experience on "self-affirmation," "passion for teaching," and "positive belief". The measurement can reflect teachers' effectiveness evaluations in AI-supported teaching, which has important implications for theoretical research and practical application in emerging technology teaching. This research discusses the practicalities of AI-supported teaching.

Keywords: Artificial Intelligence (AI), AI-supported teaching applications, Self-efficacy, AI-supported teaching behaviour

Introduction

Taiwan's 21 major industries, evaluating the urgency of the talent shortage based on the ratio of new demand to industry employment. It was found that industries such as artificial intelligence application services, offshore wind power generation, and IC design have relatively urgent needs for talent, accounting for 13.9%, 13.7%, and 11.7% respectively (Focus Taiwan CNA English News, 2021; Taiwan National Development Council, 2024;

Taiwan News, 2021). The Ministry of Education of Taiwan plans to include AI courses in elementary and high school essential education curriculum planning in 2020 and gradually complete examples of AI textbooks and lesson plans from universities to elementary schools, showing the importance of AI education (Darayseh, 2023; Taiwan Executive Yuan, 2019; Oberländer et al., 2020; Wang et al., 2021).

Artificial intelligence (AI) is a technology that allows computers to perform a variety of advanced functions, including viewing, understanding, and translating speech and text languages, analysing data, and creating recommended content (Viberg et al., 2023; Yilmaz & Yilmaz, 2023). From the perspective of educational technology, the introduction of AI lies in the real-time, detailed, and accurate analysis of students' personalised learning big data. Teachers can plan adaptive learning paths and immediately grasp students' learning outcomes through AI's simulated interaction, increasing students' learning confidence. Schools can build AI artificial intelligence software and hardware equipment to allow teachers and students to use AI technology tools to monitor learning progress and provide feedback (Banihashem et al., 2022; Chou et al., 2023; Salas-Pilco et al., 2022; Viberg et al., 2023; Yilmaz & Yilmaz, 2023). The "Ministry of Education's Artificial Intelligence Technology Application and Talent Cultivation Plan in Taiwan" promotes AI education for teachers. In addition to planning courses and teacher study activities, experts and scholars were invited to develop teaching material about artificial intelligence (Chiu, 2022; Fahimirad & Kotamjani, 2018; Malik et al., 2019; Taiwan Artificial Intelligence School, 2019). Through the AI platform, schools can detect student's aptitudes and best learning methods and help students learn (Alhwaiti, 2023; Glerum et al., 2020; Marouf, 2019; Murphy, 2019; Ng et al., 2023). Teachers can combine ICT and AI technology to build various levels of language teaching platforms, as well as diagnosis and learning recording and tracking counselling to improve students' ability (Chiu, 2022; Latikka et al., 2019; Simonov et al., 2019; Wang & Wang, 2022; Wang et al., 2021).

Regarding high school teachers, AI education application ability affects not only the AI industry's human resources training but also the AI teaching profession; the application of educational technology is huge (Dexter, 2023; Saubern et al., 2020; Seema, 2021). Education units are responding to the advancement of AI education by promoting AI education and its teacher training courses or advanced training content. The key factor in demonstrating AI teaching is that teachers have a high level of "AIS-TASE", and it is a crucial issue for teachers to be able to make breakthroughs in the classroom (Darayseh, 2023; Ng et al., 2023; Seema, 2021; Şendurur & Yilidrim, 2019). It is believed that when teachers are engaged in AI-supported teaching, their awareness of their AI-supported teaching ability and their perceptions and beliefs that can affect students' learning degree also affect teachers' AI-supported actions.

AI-supported teaching applications self-efficacy (AIS-TASE) refers to teachers' self-judgment ability and belief in using AI-supported information technology. It is the belief in self-affirmation, adhering to hard work, passion for teaching, and positive belief (Alhwaiti, 2023; Chou et al., 2023; Darayseh, 2023). Oran (2023) proposed teachers' self-efficacy (TSE) beliefs not only affect teachers' performance and motivation but also affect students' academic success. Teachers' acceptance of using artificial intelligence in the classroom is high and positively correlated with self-efficacy, ease of use, expected benefits, attitudes, and behavioural intentions (Darayseh, 2023). Among them, the research results confirmed that occupational well-being is related to teaching self-efficacy, performance expectancy, effort expectancy, social influence, and habits that teachers are influenced by the constructs established in the UTAUT2 model when adopting artificial intelligence (Alhwaiti, 2023). Chou et al. (2023) found that teachers' self-efficacy includes the teachers' self-confidence and expectations for future performance, including resource support, innovative teaching, professional learning, learner needs, and self-reflection. Teachers' teaching experience is crucial to developing self-efficacy beliefs, which may affect teachers' self-efficacy in AI-supported teaching applications (Alhwaiti, 2023; Chou et al., 2023; Darayseh, 2023; Oran, 2023).

Salas-Pilco et al.'s (2022) research pointed out that it is valuable for teachers to effectively use artificial intelligence and learning analytics (LA) technology in teaching practice to support teacher education decision-making. LA dashboards and feedback can provide support for teachers and increase teacher self-efficacy (Carolien et al., 2023; Wang et al., 2023). LA dashboards provided insights based on data collected by learning management systems and student information systems, helping teachers monitor students' learning strategies and providing a scientific basis for learning (Viberg et al., 2023; Wang et al., 2023). Learning analytics (LA) has the potential to provide personalised, immediate, and relevant feedback, and LA plays an important role in enhancing classroom feedback practices (Banihashem et al., 2022; Carolien et al., 2023). AI-supported teaching applications are concerned, information visualisation is the most commonly used method in LA-based feedback systems. Using LA to support teaching feedback can simply make it easier for teachers to manage (Banihashem et al., 2022). Educators and students have received increasing attention to improve feedback practice services in technology-mediated learning environments in higher education, forming LA dashboards to support student learning (Banihashem et al., 2022). Banihashem et al. (2022) indicated that feedback is an important part of adaptive teaching and a powerful intervention method for teachers to adapt to students' needs. The LA dashboards serve as a tool for AI-supported teaching applications to promote teaching activities (Carolien et al., 2023; Salas-Pilco et al., 2022).

The self-efficacy topics involved mainly refer to the belief evaluation of teachers' general teaching ability, and the discussion of the self-efficacy of this unique type of AI-supported

teaching has yet to be developed (Alhwaiti, 2023; Bandura, 2019; Clark & Newberry, 2019; Dexter, 2023; Oran, 2023; Şendurur & Yilidrim, 2019). Therefore, this study not only defines the theoretical meaning and characteristics of self-efficacy in AI-supported teaching through the collation of related theories and documents but also explores this structure with empirical data through the development of an "AIS-TASE among teachers" that structures of the concepts, and the relationships with related variables can provide theoretical and practical contributions to the implementation of AI-supported teaching. This study is to address the following three issues.

1. To develop a teacher AIS-TASE measurement to examine reliability and validity and to explore the relationship between teachers' AIS-TASE and behaviour.
2. To identify the relevant factors that are tested to explore the relationship between individual variables and AIS-TASE.
3. To explore the relationship between teachers' AIS-TASE and AI-supported teaching behaviour.

Literature review

Teachers' self-efficacy in AI teaching

"AI teaching self-efficacy" refers to the self-efficacy evaluation of teachers in the implementation of AI teaching. Its content integrates the two concepts: AI teaching and teacher self-efficacy. It also extends the concept of teacher self-efficacy to AI teaching self-efficacy, and is an important indicator to predict teachers' AI teaching behaviour (Bandura, 2019; Bin, 2019; Bojorque & Pesántez-Avilés, 2019; Darayseh, 2023; Oran, 2023). AI teaching self-efficacy is personal judgment and confidence in teachers' ability to complete certain computer tasks, as well as personal self-judgment of their AI capabilities (Chou et al., 2023; Handtke & Bögeholz, 2019; Haristiani, 2019). Bandura's concept of self-efficacy affects related research on the effectiveness of AI teaching. Self-efficacy in AI teaching not only affects whether individuals are willing to use AI and their emotional response to AI teaching, but also affects their AI teaching performance (Asthana & Hazela, 2020; Bandura, 2019). Many research results show a positive relationship between AI teaching self-efficacy and AI teaching performance (Alhwaiti, 2023; Chou et al., 2023; du Boulay, 2016; Guilherme, 2019).

Asthana and Gupta (2019) found that the higher the self-efficacy of teachers in AI teaching, the stronger their intention to learn and use AI teaching, and the more they are willing to face computer-related problems. Doğru (2017) learned that the higher the self-efficacy of users in AI teaching, the more they can improve their AI teaching performance. Bin (2019) and Guilherme (2019) show that the self-efficacy of AI teaching has a positive relationship with the effectiveness of personal AI teaching. Scholars believe that because

specific self-efficacy is dynamic, long-term observation of dynamic self-efficacy changes is necessary to correctly explain the relationship between self-efficacy and learning performance (Handtke & Bögeholz, 2019; Huang, 2018). Scholars believe that the focus of self-efficacy in AI teaching is teachers evaluating whether they can use AI teaching knowledge to achieve specific tasks rather than simply reflecting the knowledge or skills of AI possessed by individuals (Alhwaiti, 2023; Hamed et al., 2018; Jung et al., 2019; Tuomi, 2018). The self-efficacy of AI teaching mainly lies in the teachers' judgment and self-confidence in their AI teaching ability, not the behaviour on AI.

In this study, on the validity procedure of the measurement scale, AI teaching was used as the validity criterion of the correlation criterion. It is worth noting that since the self-efficacy of AI teaching differs from general self-efficacy, but reflects the belief of the individual's AI ability across different fields, this study focuses on the measurement content of self-efficacy of AI teaching, especially focusing on teachers' AI measure of belief in the ability to produce the results of AI teaching activities. As the concept of "self-efficacy in AI teaching" is still unavailable in the local literature, this study refers to the relevant literature on teachers' self-efficacy assessment tools and incorporates relevant concepts of teacher professional development.

Teachers' AI teaching self-efficacy and teaching behaviour

The concept of "self-efficacy in AI teaching" is based on the social learning theory of Bandura (1977). The theory of self-efficacy specifically states that a high degree of self-efficacy is a necessary condition for the discovery of new knowledge or works (Bandura, 2018, 2019). It is believed that when teachers are engaged in AI teaching, the awareness of their AI teaching ability and their perceptions and beliefs that can affect students' degree of learning also affect teachers' AI actions. Bandura (1997) pointed out that the individual's efficacy expectation is the main determinant of the individual's goal-setting, activities choice, and willingness to expend effort. Therefore, in teaching practice, self-efficacy is bound to play a very important role as an important motivational force for engaging in specific behaviour, which in turn enables individuals to take effective actions to complete tasks (Bandura, 2013, 2019; Chou et al., 2023; Oran, 2023).

Malandrakis et al. (2018) regard self-efficacy as an important motivational component in their action models, and find that self-efficacy is an important factor in predicting teaching performance. However, the research by Malandrakis et al. (2018) did not separate self-evaluation of AI effectiveness from self-evaluation of general work efficiency, so the impact on self-efficacy evaluation of performance is unknown. Research by John (2015) and Hatlevik and Hatlevik (2018) distinguishes the two, and finds that general self-efficacy differs from work self-efficacy and can effectively predict performance. From the course of development, people have developed different factors and types of self-efficacy

evaluations in different assignments or work content. Therefore, the concept of self-efficacy should be separated according to different work content in order to discover the most meaningful interpretation effect.

Malik et al. (2019) verified that AI efficacy beliefs are directly related to teachers' AI teaching behaviour, confirming the existence of the concept of AI self-efficacy, which is different from job self-efficacy. AI is domain-specific, so AI self-efficacy also differs from general self-efficacy. It reflects the self-belief or expectation of AI performance of a person working in different fields (Malandrakis et al., 2018). Scholars believe that AI is the interaction between skilled performance and the use of AI skills in specific fields. Research on the self-efficacy of AI teaching should define self-efficacy from the perspective of special teaching or behavioural models (Darayseh, 2023; Mambwe et al., 2019). Therefore, this is the main argument for the self-efficacy of AI teaching advocated by this research.

Teachers' self-efficacy in AI teaching refers to the ability to use AI technology intelligence and emerging educational technology application intelligence to handle cross-field learning and solve problems (Alhwaiti, 2023; Chou et al., 2023; Huang et al., 2019; Tuomi, 2018). The application level of AI education includes collaborative learning, discussion monitoring, teaching and research assistants, as well as personalised learning guides and comparisons for learners (Zawacki-Richte et al., 2019). In terms of the connotation of AI teaching, Choong et al.'s (2020) results show that AI teaching dimensions of teachers are positively related to teaching behaviour. Practical significance of teachers' personal effectiveness depends to a large extent on their efforts in teaching, their ability to make decisions and their persistence in solving problems (Darayseh, 2023; Oran, 2023; Sahin & Yilmaz, 2020; Şendurur & Yilidrim, 2019). School management and policy makers need to be urged to develop effective human resources plans and programs to build trust in their organisation and improve teacher self-efficacy. These measures may include socialisation programs that, when training for perceived tasks and responsibilities, can inculcate teachers' inherent nature, self-confidence, and interpersonal skills, which can have a significant impact on teachers' AI teaching behaviour (Murphy, 2019; Oran, 2023; Sezer & Yuilmaz, 2019; Simonov et al., 2019).

Jaengaksorna et al. (2015) believe that the research results of measuring models for teachers' self-efficacy and motivation are learned. There are three indicators for measuring successful self-efficacy models based on empirical data: student participation, teaching strategy, and classroom experience. Effectiveness includes general effectiveness and effectiveness in management (Darayseh, 2023; Oran, 2023; Tärning et al., 2019). Tussyadiah and Miller (2019) believe that teachers will have plans to put AI ideas into action and seek support from resources, and will show AI at every step of the teaching context, flexibly applying teaching through AI teaching plan to encourage the display and development of students' AI learning results (Xia, 2019). Nie et al. (2012) compiled the

"Teaching Efficacy Scale (TES)", which includes instructional efficacy, classroom management efficacy, and efficacy to assess learning, including: teaching execution, class management, learning assessment, efficacy in parent-teacher communication, teaching innovation/reform, and environmental transformation. Overall, the research results support the concept of multi-dimensional teacher self-efficacy (Teo & Koh, 2010).

When teachers are fully confident that they are engaged in AI teaching, that is, when the teacher feels "I can do it," the realisation of AI teaching is most likely. This psychological trait is referred to as "AI teaching self-efficacy". It means teachers' perception and belief in AI teaching ability and their ability to influence students' AI learning level when they are engaged in AI teaching (Tezer, & Soykan, 2017; Zawacki-Richte et al., 2019). From the above, it can be seen that in addition to the traditional personal characteristics and ability factors, the study of AI teaching behaviour may be more important from the perspective of self-efficacy. The measurement tools developed by this research can reflect teachers' effectiveness evaluation in the teaching field, which has important implications for the theoretical research and practical application of teachers' self-efficacy.

Methodology

Participants and study context

1. Pre-test participants: This study first used cluster sampling to establish a pre-sample for the preliminary scale items. A total of 189 teachers (108 males and 81 females) from 12 schools participated in the pre-test questionnaires, and the scale was structured and the quality of the questionnaire items was inspected after the pre-test questions were collected and the respondents' answers were reviewed.
2. Formal-test participants: participants that treated 1456 senior and vocational high school teachers from 22 publics and 23 private senior and vocational high schools and adopted random and cluster sampling of class with teachers' teaching background. Teachers of 45 schools stratified for the region that calculated the questionnaire number for sampling 425 (Krejcie & Morgan, 1970). To increase the recovery of questionnaires, the number of questionnaires distributed was four times the number of samplers. The cluster sampling method divided the population of high school teachers according to their teaching background into senior and vocational high school teachers' subjects: industry, business, catering and tourism, and other subjects. Senior and vocational high school teachers and schools were chosen from computer-randomly selected sample departments and were based on teachers' information (e.g., gender, teaching experience, job position, teaching background, school attributes, and technology-instruction integration experience) as shown in Table 1.

Table 1 Distribution of participants' background in formal scales (N=1456)

Basic information	Group	No of participants	%
Gender	1. Male	848	58.2%
	2. Female	608	41.8%
Teaching experience	1. 5 Years (and below)	366	25.2%
	2. More than 5 years and less than 10 years	438	30.2%
	3. More than 10 years and less than 15 years	400	27.5%
	4. Over 15 years	252	17.1%
Current post	1. Full-time teachers	1090	74.8%
	2. Teachers and administrator	366	25.2%
Teaching background	1. Normal higher school subject (Chinese, English, mathematics, history, geography, civic education, physics, chemistry, biology, earth sciences, etc.)	460	31.6%
	2. Industry	298	20.5%
	3. Business	310	21.3%
	4. Catering & Tourism	191	13.1%
	5. Others subject	197	13.5%
School attributes	1. Public	790	54.3%
	2. Private	666	45.7%
Technology-instruction integration AI experience	1. Yes	836	57.2%
	2. No	620	42.8%
Total		1456	

According to the data published by the Taiwan Statistics Department of the Ministry of Education (2021a, 2021b), the group comprised 528 higher schools, 18,593 classes, and 51,201 teachers of public and private high schools. These included 5877 classes in normal higher school subjects (Chinese, English, mathematics, history, geography, civic education, physics, chemistry, biology, earth sciences, etc.), 3814 classes in industry, 3952 classes in business, 24368 classes in catering & tourism, and 2512 classes in other subjects (Child Care, Housekeeping, Maritime, Drama, etc.). Those teachers include teaching courses in vocation-related subjects, technology courses, and industry programs (Taiwan Statistics Department of the Ministry of Education, 2021a, 2021b).

In total, 1700 questionnaires on the scale were distributed, 1484 questionnaires were returned, 28 invalid questionnaires were eliminated, and 1456 effective questionnaires were returned, for a response rate of 86%. Collecting the respondents' opinions on the questions and processing the waste papers, eliminating the blank questionnaires or the questionnaires with too many unanswered questions, were carried out. In addition, questionnaires in which the respondent checked all the same answers or hastily checked them were also excluded.

Study design and procedure

A cross-validation of the scale structure was performed by confirmatory factor analysis, and the related variables were tested the reliability and validity of the scale.

1. Questionnaire draft: The AIS-TASE scale was 42 questions in the first draft and measured high school teachers' abilities that specific teaching situation and teaching tasks of the teacher engaged in AI-supported teaching, as shown in Table 2. In preparation for the topic, this questionnaire draft refers to the "Teachers' Computer Self-Efficacy Scale" and "Online Learning Environment Self-Efficacy Scale" developed by Yu (2007). The

Table 2 The AIS-TASE scale was 42 questions in the first draft

Item description		Referenced research and adopted instrument
1.	The direction I want to develop in the future has a lot to do with the teaching content of the AI teaching course.	Matosas-López et al. (2019); Malandrakis et al. (2018); Zhou (2019); Bandura (2019); Bin (2019); Bojorque & Pesántez-Avilés (2019); Alhwaiti (2023); Chou et al. (2023)
2.	In the AI teaching course, the affirmation gained has expanded my life experience	
3.	Through the AI teaching course, I can have fun from the teaching process.	
4.	The AI teaching course allows me to enjoy the full experience of applying previous knowledge.	
5.	Analyse the teaching results of AI teaching, allows me to experience the excitement of exploring new knowledge.	
6.	Acknowledge yourself and accept your feelings as they are.	
7.	People with a high sense of self-affirmation can agree that "just be yourself", and even if they have shortcomings, they can accept themselves without denying themselves.	
8.	When students complete AI teaching works, they will get a sense of accomplishment.	Tärning et al. (2019); Simonov et al. (2019); Matosas-López et al. (2019); Choong et al. (2020); Darayseh (2023); Oran (2023)
9.	The ability to learn AI teaching should allow me to experience the satisfaction of being exposed to new information.	
10.	The ability to learn AI teaching should allow me to experience the satisfaction of teaching applications.	
11.	I am willing to learn more knowledge and skills of AI teaching because it can be used in my teaching.	
12.	I care very much whether I learn how to apply the knowledge and skills taught in AI teaching courses.	
13.	Teaching intention refers to what effect you design the topics and links in the lesson plan to achieve and what you want students to understand.	
14.	Teaching design is to arrange various teaching elements in an orderly manner and determine appropriate teaching plans based on the requirements of curriculum standards and the characteristics of the teaching objects.	
15.	I am willing to take the time to learn how to do AI teaching because it is quite worthwhile.26. I think that acquiring the knowledge and skills of AI teaching will help me in the future.	Jaengaksorna et al. (2015); Xia (2019); Nie et al. (2012); Malandrakis et al. (2018); Tuomi (2018); Zawacki-Richte et al. (2019)
16.	I am trying to tap the knowledge and skills of doing AI teaching because everyone said that it is important to have the AI specialty.	
17.	If I don't finish the AI teaching results, I will feel bad.	
18.	If I don't take the time to study the knowledge of AI teaching, I will feel seriously disappointed.	
19.	If I didn't take the time to understand the knowledge and skills needed to do AI teaching, I would feel sorry for everyone.	
20.	I will feel guilty if I have not completed the results of AI teaching.	
21.	Teachers love and value their work in which they invest themselves completely.	
22.	I think my performance in AI teaching courses cannot be changed, and it is impossible to improve.	Teo & Koh (2010); Teze & Soykan (2017); Zawacki-Richte et al. (2019); Mambwe et al. (2019); Huang et al. (2019); Chou et al. (2023); Darayseh (2023)
23.	I don't think that the publication of AI teaching results will be of any value to me.	
24.	To me, taking AI teaching courses has no meaning at all.	
25.	I have never been able to focus on AI teaching courses.	
26.	I think that acquiring the knowledge and skills of AI teaching will help me in the future.	
27.	Technology anxiety means that consumers are afraid of using technology, have negative opinions about technology, and try to avoid using technology-related tools.	
28.	Because you can think positively, you can not only think about different opinions and ideas with a more open attitude, but also be less easily shaken by setbacks or failures.	Tussyadiah & Miller (2019); Murphy (2019); Hatlevik & Hatlevik (2018); Malik et al. (2019); Matosas-López et al. (2019); Alhwaiti (2023); Oran (2023)
29.	The results of my AI teaching match my own internal thoughts and needs.	
30.	The major discussed in the AI teaching class is one of the specialties I want to develop in my future life.	
31.	I hope to see my professional knowledge and skills grow a lot during the AI teaching process.	
32.	A positive attitude is an emotional attitude, which certainly means positive thinking.	
33.	We face troubles and problems with an optimistic attitude and hope for a positive outcome.	
34.	Cultivate your ability to "think positively".	
35.	I do good AI teaching because I really want to learn everything taught in AI teaching courses.	Sezer & Yuilmaz (2019); Malandrakis et al. (2018); Sahin & Yilmaz (2020); Şendurur & Yilidrim (2019); Darayseh (2023); Oran (2023)
36.	With the ability to do AI teaching, I think this must be done, otherwise it will bother me.	
37.	I am trying to tap the knowledge and skills of doing AI teaching because everyone said that it is important to have the AI specialty.	
38.	Teachers' positive thoughts on decision-making and judgment when faced with AI application teaching matters and student behaviour problems.	
39.	Teachers can become self-aware of their beliefs about AI applications and improve their self-control and management abilities.	
40.	Teachers maintain positive values and concepts regarding the application of AI education in teaching work and student learning.	
41.	Teachers are optimistic about their experience, judgment, and behavioural reactions to various AI applications in teaching-related matters.	

AIS-TASE scale was built based on the research tools of Malandrakis et al. (2018), Matosas-López et al. (2019) and Zhou (2019).

2. Expert examination: The AIS-TASE scale originally had 42 questions. After review by six experts, 11 questions were deleted and 31 questions were retained. Three university professors with more than five years of AI teaching application experience determined the surface validity of the questionnaire. At the same time, three senior and vocational high school teachers with more than seven years of teaching experience of computer and ICT technology courses were asked to check the meaning and sentences of the scale, provide corrections, and test the scale as a reference for the researchers to modify the questionnaire. Six experts examined the questionnaire contents and modified the item descriptions to understand the questionnaire better and reviewed the characteristics of AIS-TASE in senior and vocational high school. After review by six experts, 11 items were deleted. The criteria for deletion are as follows: (1) The measurement items of the questionnaire can be closer to the survey topic; (2) The measurement items of questionnaire can be reviewed to confirm that the textual description of each topic was appropriate and clear and to establish its content validity. The validity of the expert content was confirmed before the pre-test scale with 31 items.

3. Item analysis: The purpose of item description statistics is to use each item's descriptive statistics to test the project's good or bad. There are three tendencies, such as too-high and too-low averages, minor standard deviations, and severe skewness. The representative scale items may identify the problem of insufficient degree (Hair et al., 2010; Ho & Yu, 2015). The pre-test questionnaire of the AIS-TASE scale was tested by 189 high school teachers (108 males and 81 females), the pre-test participants from 12 schools participated in the pre-test questionnaires, consisting of 52% males, 48% females, 56% full-time teachers, and 44% teachers and administrators, the scale was structured, inspected, and completed with 31 questions. The scale used a five-point Likert scale ranging from "completely inconsistent" to "fully consistent," from 1 to 5. After item analysis of the pre-test questionnaire, 6 items that did not reach a significant level were deleted, and 25 questions were retained for factor analysis to test the validity of the scale and became a formal questionnaire. The project analysis content is shown in Table 3.

4. The factor analysis procedure: After analysis of the test questions, those with corrected item-total correlation values of less than 0.30 were excluded, according to the commonly-used criteria. Based on the principal factor method of 189 pre-sampling, after obliquely turning the axis and taking the eigenvalues greater than 1. This research used exploratory factor analysis, the total variance explained was 70.43%, and the factor loading of each item was between .628 and .989 (Henson & Roberts, 2006). The subscales' factors, number of questions, reliability, and validity are shown in Table 4.

Table 3 Questionnaire item analysis table

Item	Extreme group comparison	Correlation test		Homogeneity test			Note
	Decision value	Items related to total score	Correction items related to total score	α value after item deletion	Commonality	Factor loading	
1	3.862***	.378***	.329	.917	.158	.398	delete
2	4.630***	.426***	.370	.917	.194	.441	Keep
3	9.308***	.681***	.653	.913	.506	.711	Keep
4	5.494***	.473***	.430	.916	.227	.477	Keep
5	4.589***	.426***	.372	.917	.191	.437	Keep
6	7.389***	.660***	.629	.913	.471	.686	Keep
7	8.548***	.702***	.673	.912	.512	.716	Keep
8	9.128***	.749***	.722	.912	.571	.755	Keep
9	7.959***	.656***	.621	.913	.483	.695	Keep
10	7.656***	.713***	.681	.912	.540	.735	Keep
11	8.492***	.714***	.684	.912	.540	.735	Keep
12	3.251***	.425***	.376	.916	.211	.459	Keep
13	5.137***	.421***	.364	.917	.193	.439	Keep
14	7.578***	.590***	.547	.914	.367	.605	Keep
15	4.837***	.485***	.435	.916	.257	.507	Keep
16	5.631***	.536***	.489	.915	.297	.545	Keep
17	7.642***	.553***	.516	.915	.337	.581	Keep
18	10.387***	.702***	.672	.912	.558	.747	Keep
19	8.030***	.691***	.660	.913	.550	.742	Keep
20	11.409***	.795***	.773	.911	.673	.820	Keep
21	8.917***	.672***	.638	.913	.513	.716	Keep
22	11.247***	.710***	.680	.912	.560	.749	Keep
23	3.600***	.354***	.295	.918	.065	.255	delete
24	.295	.063	.001	.922	.001	-.029	delete
25	4.202***	.402***	.346	.917	.093	.305	delete
26	4.052***	.335***	.277	.918	.065	.255	delete
27	4.267***	.446***	.393	.916	.142	.376	delete
28	6.095***	.540***	.487	.915	.228	.477	Keep
29	6.582***	.531***	.486	.915	.224	.474	Keep
30	5.168***	.462***	.409	.916	.152	.390	Keep
31	6.373***	.592***	.543	.914	.289	.538	Keep
standard	≧3	≧.4	≧.4	≦.917	≧2	≧4	

*p<.05 **p<.01 ***p<.001

Table 4 Summary table of factor analysis of AI-supported teaching applications self-efficacy questionnaire

Factor	Item	Factor load	Eigen values	Explaining the amount of variation (%)	Cumulative explanatory variation (%)
Self-affirmation	11. When students complete AI teaching works, they will get a sense of accomplishment.	.806	4.264	17.055	17.055
	08. Through the AI teaching course, I can have fun from the teaching process.	.786			
	10. Analyse the teaching results of AI teaching, allows me to experience the excitement of exploring new knowledge.	.760			
	09. The AI teaching course allows me to enjoy the full experience of applying previous knowledge.	.723			
	07. The ability to learn AI teaching should allow me to experience the satisfaction of being exposed to new information.	.683			
	06. I hope to see my professional knowledge and skills grow a lot during the AI teaching process.	.628			
Passion for teaching	25. I am willing to learn more knowledge and skills of AI teaching because it can be used in my teaching.	.766	3.916	15.665	32.720
	23. I care very much whether I learn how to apply the knowledge and skills taught in AI teaching courses.	.729			
	22. I do good AI teaching because I really want to learn everything taught in AI teaching courses.	.721			
	26. I think that acquiring the knowledge and skills of AI teaching will help me in the future.	.691			
	24. I am willing to take the time to learn how to do AI teaching because it is quite worthwhile.	.681			
	21. With the ability to do AI teaching, I think this must be done, otherwise it will bother me.	.657			
	16. I am trying to tap the knowledge and skills of doing AI teaching because everyone said that it is important to have the AI specialty.	.632			
Adherence to hard work	20. If I don't finish the AI teaching results, I will feel bad.	.826	3.700	14.800	47.519
	18. If I don't take the time to study the knowledge of AI teaching, I will feel seriously disappointed.	.807			
	19. If I didn't take the time to understand the knowledge and skills needed to do AI teaching, I would feel sorry for everyone.	.794			
	17. I will feel guilty if I have not completed the results of AI teaching.	.768			
Negative consciousness	30. I think my performance in AI teaching courses cannot be changed, and it is impossible to improve.	.893	3.275	13.100	60.619
	31. I don't think that the publication of AI teaching results will be of any value to me.	.851			
	28. To me, taking AI teaching courses has no meaning at all.	.836			
	29. I have never been able to focus on AI teaching courses.	.778			
Positive belief	02. The direction I want to develop in the future has a lot to do with the teaching content of the AI teaching course.	.850	2.452	9.807	70.426
	05. The major discussed in the AI teaching class is one of the specialties I want to develop in my future life.	.812			
	04. The results of my AI teaching match my own internal thoughts and needs.	.639			
	03. In the AI teaching course, the affirmation gained has expanded my life experience	.653			

Note: 1. KMO value = .895, Bartlett's spherical test x2 = 2615.366, the rotation axis converges to 8 iterations.

2. The total variance of the first factor analysis cumulative performance = 70.426

Measurements

The AIS-TASE scale was 25 items in total were obtained and five subscales were named: (1) Self-affirmation (6 items, Cronbach's α= .89). For example, through the AI teaching course, I can have fun from the teaching process; (2) Passion for teaching (7 items, Cronbach's α= .90). For example, I care very much whether I learn how to apply the knowledge and skills taught in AI teaching courses; (3) Adherence to hard work (4 items, Cronbach's α= .88). For example, I will feel guilty if I have not completed the results of AI teaching; (4) Negative consciousness (4 items, Cronbach's α= .85). For example, I have never been able to focus on AI teaching courses; and (5) Positive belief (4 items, Cronbach's α= .89). For example, the major discussed in the AI teaching class is one of the specialties I want to develop in my future life. The developed scales for each dimension adapted or referenced research instrument and the reliability of the AIS-TASE scale.

Data analysis

The exploratory factor analysis of this study is based on the extraction of the principal axis factors of SPSS. In addition, the measurement mode analysis of the structural equation mode uses AMOS software to verify the appropriateness of the factor structure of the measurement tool.

Research results

Exploratory factor analysis to simplify the content of the scale

Exploratory factor analysis was conducted on the extracted items to determine the construct validity of the sub-scales and scales. SPSS was used to carry out the exploratory factor analysis. Factors with eigenvalues over 1 and principal components analysis were adopted. Since correlation among the factors was over 3, the factors were extracted by oblique rotation (Hair et al., 2010). The analysis showed that KMO reached .895, the Bartlett Sphericity Test was significant, the degree of freedom was 105, and commonality was over .6, suggesting that the scale is valid for factor analysis (Hair et al., 2006). Based on the results of the first exploratory factor analysis, 25 items were categorised into five major factors that could explain 70.43% of the variance. Most items met the expected factors in pretest, but some items were allocated as independent factors. In order to extract definite and simple factors, they were categorised into three groups, and items with a high load and stable fall factors were selected. Based on the second principal components analysis, five factors with respective eigenvalue over 1 were selected. Screed test was slack after the third factor, and thus five factors were extracted. The total variance explained was 70.43%. Upon rotation, each factor contained four and seven items, and the factor loading of each item

was between .628 and .989, proving that the scale is valid (Henson & Roberts, 2006). In this stage, 25 items were retained for formal test.

In addition to the indicators mentioned above, pre-exam selection criteria were used in conjunction with exploratory factor analysis to simplify the content of the scale. This pre-sampling used the principal factor method of 189 teachers. A total of 25 items were obtained and named under "self-affirmation" (6 items, M=3.78), "Passion for teaching" (7 items, M=4.27), "adherence to hard work" (4 items, M=4.03), "negative consciousness" (4 items, M=3.10), and "positive belief" (4 items, M=4.40). The total explanatory variation of the five factors was 70.426%. The overall factor structure analysis results are shown in Table 5. The scale was designed for teachers' self-assessment results of AI-supported teaching behaviour. The scale for AIS-TASE scale includes five constructs:

(1) Self-affirmation: Through the AI-supported teaching process, I can gain perceptions of new knowledge, teaching pleasure, and professional growth. The subscale's reliability in terms of Cronbach's α coefficient is .89.

(2) Passion for teaching: The knowledge and skills of AI-supported teaching will be beneficial and helpful to students, and I am willing to spend time learning AI-supported teaching. The subscale's reliability in terms of Cronbach's α coefficient is .90.

(3) Adherence to hard work: The subscale's reliability in terms of Cronbach's α coefficient is .88.

(4) Negative consciousness: Individuals believe that AI-supported teaching is meaningless and has a negative attitude. The subscale's reliability in terms of Cronbach's α coefficient is .85.

(5) Positive belief: AI-supported teaching will meet my ideas and needs and expand the teaching experience. The subscale's reliability in terms of Cronbach's α coefficient is .89.

The scale's reliability in terms of Cronbach's α coefficient is .91. In addition to the above scale, this study asked two self-assessment questions (I am a person who uses AI information technology to teach; I dare to use AI information better than others teachers of school) as simultaneous targets to understand the relationship between the subject's self-evaluation of personal AI and the internal factors of the pre-test scale.

Table 5 Statistical test table of five factors of AI-supported teaching applications self-efficacy

Factor	Item	Average	Standard deviation	Skewed	Kurtosis	Cronbach α	Test-retest reliability
Self-affirmation	6	3.78	1.00	-0.16	0.01	.89	.86
Passion for teaching	7	4.27	0.93	-0.36	0.28	.90	.87
Adherence to hard work	4	4.03	1.14	-0.49	0.22	.88	.84
Negative consciousness	4	3.10	0.96	-0.40	0.72	.85	.83
Positive belief	4	4.40	1.08	-0.31	-0.43	.89	.85
AI-supported teaching applications self-efficacy (overall)	25	4.05	0.67	-0.15	0.56	.87	.86

Confirmatory factor analysis identifies the composition of latent variables

In the pre-test stage, the scale's factor structure was analysed by an exploratory factor analysis (EFA), and three factors were found. A formal sample was used for the confirmatory factor analysis (CFA). With AMOS software, the most approximate method was used to perform parameter estimates to confirm the factorial validity of the scale. In the mode setting, the four factors have corresponding measurement problems, forming three first-order potential factors. Furthermore, according to the existence of the relationship between various factors, this study tested two models: the single-order orthogonal mode (independent and uncorrelated between first-order factors) and the single-order oblique mode. The model scaling was based on the first parameter of each factor being set to a reference parameter of 1.0. The results of the mode adaptation analysis show the adaptation of the single-order orthogonal model: χ^2 = 714.36, p <.001, df = 91, χ^2 / df = 7.92, RMSEA = .121, GFI = .871, CFI = .861, TLI = .836, indicating no correlation between the model and the observation data, which is not relevant. After factor correlation is included in the estimation, the adaptation of the single-order oblique crossing mode is greatly improved (χ^2 = 383.43, p <.001, df = 88, χ^2 / df = 4.39, RMSEA = .077, GFI = .925, CFI = .941, TLI = .927), showing that the theoretical model fits well with the observation score. It indicates that there are correlations between AI-supported teaching applications and self-efficacy factors. In application, a single-order oblique mode can be established.

The coefficient values of the five factors are .89, .90, .89, .85, and .89, and the full-scale Cronbach's α is .87 for the total amount. The internal consistency of the table is relatively high. In addition, this study also conducted retest reliability. Three weeks later, it was retested. The correlation between the two tests was .92, which reached a significant level, showing that the stability of "negative consciousness" is poor. This scale has good retest quality (Bentler & Bonett, 1980; Hair et al., 2010).

Correlation validity analysis between AIS-TASE and efficacy standard variables

A correlation was indicated between these effectiveness standards and various factors of AI-supported teaching applications' self-efficacy. Table 6 shows that the full-scale scores are significantly related to the three effectiveness standards; each factor is also significantly related to the three effectiveness standards. Three effectiveness standards were "I am a person who makes good use of AI information technology to teach", "I am a person who dares to use AI information technology to teach", and "AI teaching behaviour". Among the correlations between various factors and effectiveness standards, the ideal factor is the first factor, "self-affirmation," which correlates with teaching AI-supported teaching behaviour as high as .76 (p <.001), showing the more positive the effectiveness of teaching strategies, the higher the frequency of teaching AI-supported teaching behaviour. The

Table 6 Correlation between AI-supported teaching applications self-efficacy scale and efficacy standard variables

	I am a person who makes good use of AI information technology to teach	I am a person who dares to use AI information technology to teach	AI teaching behaviour
Self-affirmation	.42***	.41***	.76***
Passion for teaching	.39***	.37***	.75***
Adherence to hard work	.26***	.32***	.66***
Negative consciousness	.24***	.31***	.68***
Positive belief	.41***	.40***	.74***
AI-supported teaching applications self-efficacy (overall)	.44***	.43***	.76***

***p<.001

correlation between this factor and the two AI self-assessment efficacy targets is .42 (p <.001).

Teachers' background variable analysis in the AIS-TASE

Teachers' gender

The results are shown in Table 7 for teachers' gender was tested by MANOVA. The Wilk's λ test reaches a significant level (Wilk's λ = .927, p <.001), indicating that gender reaches significant differences in the overall level of AIS-TASE (η^2 = .037). The intensity of the effect of gender on AIS-TASE is .037. When comparing the gender differences of various factors, in "self-affirmation" (F = -3.634, p <.001), "passion for teaching" (F = -.086, p <.001), "adherence to hard work" (F = -2.971, p <.001), "negative consciousness" (F = -2.860, p <.001) and other factors reached significant levels. There was no gender difference when the "positive belief" factor did not reach a significant level (t = -2.285, t = .349, p> .05).

Teaching experience

From the results of teaching experience in Table 8, it is found that the MANOVA test of teachers' teaching experience has not reached a significant level (Wilk's λ = .743, p > .05),

Table 7 Difference test between male and female teachers in AI-supported teaching applications self-efficacy (N=1456)

Factor	Male (N=848)		Female (N=608)		*F* Value
	M	*SD*	*M*	*SD*	
Self-affirmation	4.09	0.98	3.67	1.01	-3.634***
Passion for teaching	4.20	0.92	4.15	0.92	-0.086***
Adherence to hard work	4.92	0.98	3.92	1.15	-2.971***
Negative consciousness	3.02	0.94	3.97	0.97	-2.860***
Positive belief	4.31	0.92	4.39	1.12	-2.285
Wilk's λ =.927	Multivariate F=13.189*				

*p<.05 ***p<.001

Table 8 Teachers' teaching experience difference test in AI-supported teaching applications self-efficacy

Factor	5 Years (and below) (N=183)		More than 5 years and less than 10 years (N=219)		More than 10 years and less than 15 years (N=200)		Over 15 years (N=126)		*F* Value
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	
Self-affirmation	4.01	0.97	3.67	1.01	3.69	1.11	3.79	1.03	1.61
Passion for teaching	4.22	0.92	4.12	0.90	4.10	0.99	4.13	0.94	1.64
Adherence to hard work	4.15	0.98	4.02	1.09	4.01	1.01	3.98	1.12	2.61
Negative consciousness	3.09	0.95	3.08	0.93	3.09	0.97	3.01	0.95	2.42
Positive belief	4.34	0.97	4.31	1.01	4.38	1.04	4.12	1.04	1.52
Wilk's λ=.743	Multivariate F=8.751								

indicating that teachers with different teaching experiences have no obvious level on the overall level of AIS-TASE. There is no significant difference in verifying differences for each factor, indicating that teachers with different "teaching experiences" have no difference in the five factors of AIS-TASE.

Job position

The MANOVA test tested the difference in the five subscales of the job position. The results are shown in Table 9. The Wilk's λ test reaches a significant level (Wilk's $\lambda = .914$, $p < .001$), indicating that teachers' job positions reach significant in overall level of AIS-TASE ($\eta^2 = .028$), teachers' job position effect on AIS-TASE is .028. Regarding the job position differences, there are "passion for teaching" ($F = 2.31$, $p < 0.001$) and "adherence to hard work" ($F = 2.18$, $p < 0.001$). The two factors are full-time teachers, which is significantly higher than teachers and administrators; three factors do not show the difference in the job position.

Teaching background

It can be seen from Table 10 that the teaching background does not have a significant difference in the MANOVA test (Wilk's $\lambda = .927$, $p < .001$), teachers' teaching backgrounds

Table 9 Job position teachers' differences in AI-supported teaching applications self-efficacy

Factor	Full-time teachers (N=545)		Teachers and administrator (N=183)		*F* Value
	M	*SD*	*M*	*SD*	
Self-affirmation	3.89	1.01	3.67	1.13	-1.29
Passion for teaching	4.34	0.92	4.00	1.13	2.31***
Adherence to hard work	4.37	1.01	4.01	1.09	2.18***
Negative consciousness	3.12	0.99	3.04	1.04	1.36
Positive belief	4.42	1.04	4.28	1.14	-1.29
Wilk's λ=.945	Multivariate F=11.061***				

***p<.001

Table 10 Differences in AI-supported teaching applications self-efficacy for teachers' teaching background and post comparison

Factor	A. Industry (N=310)		B. Business (N=349)		C. Housekeeping (N=29)		D. Tourism (N=40)		*F* Value	*Schffe's*
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*		
Self-affirmation	4.12	0.97	3.98	1.13	3.86	1.01	3.64	1.11	36.771***	*A>B B>C C>D*
Passion for teaching	4.45	0.89	4.35	1.03	4.16	1.11	4.04	0.98	12.981***	*A>B B>C C>D*
Adherence to hard work	4.12	1.12	4.09	1.09	4.13	0.97	3.97	1.15	1.878	*ns.*
Negative consciousness	3.53	0.88	3.40	1.06	3.32	1.06	3.01	0.95	26.235***	*A>B B>C C>D*
Positive belief	4.57	1.01	4.36	1.11	4.22	0.98	4.04	1.18	3.073***	*A>B B>C C>D*
Wilk's λ=.927			Multivariate F=11.061*							

*p<.05 ***p<.001

are in the overall AIS-TASE. There are apparent differences and the intensity of the effect is η^2 = .091. The differences in teaching background for each factor found that in "self-affirmation" (F = 36.771, p <.001), "passion for teaching" (F = 12.981, p <.001), "negative consciousness" (F = 26.235, p <.001) and "positive belief" (F = 3.073, p <.001). After Schffe's comparison, the Industry teacher is significantly higher than other teaching background teachers. The "adherence to hard work" aspect alone does not show the difference in teaching background. Teachers' positive behaviour gives them greater confidence in their ability to deal with stress and crises, which is conducive to teachers' sense of efficacy and cultivating civic behaviour in the workplace (Choong et al., 2020; Sahin & Yilmaz, 2020).

School attributes

It can be seen from Table 11 that teachers' school attributes do not reach significant differences in the test of MANOVA (Wilk's λ = .911, p <.001), indicating that teachers of different school attributes in AIS-TASE. The intensity of the effect is .035 (η^2), school attributes for five factors, and it was found that there are two factors in "self-affirmation" (F = 11.682, p <.001) and "positive belief" (F = 3.073, p <.001) for private teachers are significantly higher than public teachers. Three factors do not show differences in school attributes.

Table 11 School attributes teachers' differences in AI-supported teaching applications self-efficacy

Factor	Public (N=395)		Private (N=333)		*F* Value
	M	*SD*	*M*	*SD*	
Self-affirmation	4.23	0.94	3.65	1.06	11.682***
Passion for teaching	4.38	0.84	4.16	1.04	2.92
Adherence to hard work	3.12	1.09	3.28	1.16	2.67
Negative consciousness	4.15	0.94	4.08	1.06	4.25
Positive belief	4.62	1.01	4.24	1.12	8.91***
Wilk's λ=.911	Multivariate F=9.782*				

*p<.05 ***p<.001

Technology-instruction integration AI experience

It can be seen from Table 12 that the technology-instruction integration AI experience does not reach the significance of MANOVA (Wilk's λ = .945, p <.001), indicating that teachers of different technology-instruction integration AI experience teachers in AIS-TASE. The intensity of the effect is .035 (η^2), technology-instruction integration AI experience for five factors that was found that there are three factors in "self-affirmation" (F = 10.92, p <.001), "passion for teaching" (F = 8.89, p <.001), and "positive belief" (F = 8.91, p <.001) for teachers with technology-instruction integration AI experience are significantly higher than without AI experience teachers. Two factors do not show differences in technology-instruction integration AI experience.

Discussions

The reliability and validity of teachers' AIS-TASE scale

First, at the beginning of the compilation of the AIS-TASE scale, 31 questions were prepared. Using pre-tests by 189 high school teachers, 25 items were retained after project analysis. The scale for AIS-TASE includes five constructs: self-affirmation, passion for teaching, adherence to hard work, negative consciousness, and positive belief. It performs well in testing the validity of the correlation between construction and effectiveness. The scale can be used as a tool for teachers to judge themselves in AI-supported teaching.

Table 12 Technology-instruction integration AI experience teachers' differences in AI-supported teaching applications self-efficacy

Factor	Yes (N=418)		No (N=310)		*F* Value
	M	*SD*	*M*	*SD*	
Self-affirmation	4.37	0.83	3.35	1.02	10.92***
Passion for teaching	4.35	0.71	3.76	0.98	8.89***
Adherence to hard work	4.42	0.78	3.98	1.08	3.57
Negative consciousness	3.26	0.95	4.08	1.07	5.77
Positive belief	4.52	0.89	3.71	1.21	8.91***
Wilk's λ=.871	Multivariate F=12.021*				

*p<.05 ***p<.001

Second, 1456 high school teachers were used as the official samples for measurement, and the validity evaluation was performed using three standard variables. The "AIS-TASE scale" has good reliability. This measure performs well in the validity test of the correlation between construction and effectiveness. In addition, this study also conducted a CFA verification of the AIS-TASE to assess whether the structure of this measurement tool is appropriate. The agreement indicates that the five measurement dimensions of the AI teaching self-efficacy scale were established.

The relationship between teachers' individual variables and AIS-TASE

The AIS-TASE can be used as a tool for teachers to judge themselves in AI-supported teaching. From the analysis of background variables, it is found that when comparing the gender differences of various factors, there are "self-affirmation," "passion for teaching," "adhering to hard work," and "negative consciousness". Male teachers are significantly higher than female teachers. The "positive belief" does not show gender differences. It shows that male teachers can conduct AI-supported teaching, and their perceptual judgment is higher than that of female teachers. Male teachers have a high perception of self-efficacy in AI-supported teaching, are organised in AI curriculum planning, have higher education and Q&A skills, and have better AI capabilities to explain and quickly solve student learning problems (Bin, 2019; Shaukat et al., 2019). They indicate that teachers with different teaching experiences did not differ in the five factors of AI-supported teaching applications' self-efficacy (Chassignol et al., 2018; Choong et al., 2020; Korthagen, 2017).

In job positions, full-time teachers' "passion for teaching" and "adherence to hard work" are significantly higher than those of teachers and administrators, and the remaining three factors do not show the differences in the job position (Choong et al., 2020). Teachers participate in training and education units and incorporate teaching; specialising in teaching practice can help improve teachers teaching self-efficacy (du Boulay, 2016; Opoku et al., 2022). It shows that when full-time teachers are engaged in the work of AI science, their perception and belief that they can conduct AI-supported teaching and can affect students' learning levels are higher than teachers and administrators.

When comparing the teaching background differences of each factor, the industry teacher is significantly higher than the other teaching background teachers in the four factors of "self-affirmation," "passion for teaching," "negative consciousness," and "positive belief." The "adherence to hard work" aspect alone does not show significantly. The industry teachers apply AI learning and knowledge to students, cultivate AI talents that keep pace with the times, and demonstrate the importance of professional teachers' ability to apply AI in education. Teacher effectiveness can also promote students' positive impact on learning because teachers can use relevant materials that motivate students to plan their

work and learning. If the teacher encourages students to do classroom management, the classroom can enhance students' learning abilities (Opoku et al., 2022).

When comparing the differences in school attributes of various factors, the two factors of "self-affirmation" and "positive belief" show private teachers are higher than public teachers. The remaining three factors do not show differences in school attributes. Private teachers will actively think about teaching measures in response to the development trend of AI education. It shows that private teachers participate in the application practice of AI education in schools. Students' AI knowledge can reconstruct AI. Compared with public school teachers, private school teachers have a more positive attitude, and private school teachers feel that they have more support and a higher sense of self-efficacy (Opoku et al., 2022). Schools can target specific tasks and responsibility awareness training to improve self-efficacy and provide relevant training and workshops to improve teacher effectiveness (Choong et al., 2020).

Teachers' AIS-TASE and AI-supported teaching behaviour

It shows that when teachers use technology-instruction integration AI experience, their perception have a positive attitude towards AI experience on "self-affirmation," "passion for teaching," and "positive belief". Teachers with attitude and a sense of efficacy are significant in enabling students to have a positive attitude towards computer technology. Teachers who use technology-instruction integration AI experience can grasp the factors that stimulate and influence the AI education application results and use AI intelligence as a process. Compared with technology-instruction integration AI experience, teachers who use technology-instruction integration AI experience have a more positive attitude. Without technology-instruction integration AI experience, teachers feel that they have more support for AI education applications that combine ICT and AI technology. Schools can establish various levels of teaching platforms to enhance students' abilities (Sahin & Yilmaz, 2020).

Conclusion

First, this study aimed to explore the self-efficacy of AI-supported teaching among high school teachers. This study compiled the "AIS-TASE" scale to evaluate teachers' AIS-TASE. This research scale has a reasonable basis for reliability and validity, which can make up for the lack of practical tools to assess the self-efficacy of teachers' AI-supported teaching applications. In the future, professional development and research emphasising AIS-TASE teaching can use this scale as a measurement tool. This scale can predict the readiness and confidence tendencies to understand AI-supported teaching applications' self-efficacy. It can also be used as a dependent variable measurement tool and as a measure

to assess the effectiveness of teachers' participation in AI-supported teaching applications' professional development index.

Second, this research identifies the relevant factors that are tested to explore the relationship between individual variables and AIS-TASE. The concept of self-efficacy in AI-supported teaching means that when teachers are engaged in AI-supported teaching, their perceptual beliefs about their AI-supported teaching ability can affect students' learning levels. This study's analysis of background variables found that gender, job position, teaching background, and school attributes reflect various differences in self-efficacy in AI-supported teaching. The results of this research can be used for AI-supported applications in teaching. They can be meaningfully communicated and promoted from stakeholders' perspectives in different professional fields, such as technological progress, teaching and learning, education system management, and education research.

Third, this research explores the positive relationship between teachers' AIS-TASE and AI-supported teaching behaviour. Teachers need to apply AI teaching research with a focus on AI technology applications that contribute to learning outcomes in the ICT educational environment. To fully realise the potential of AI-supported education, research focusing on the application of AI technology is particularly important. These AI-supported applications directly impact real education's learning outcomes. Therefore, when schools introduce AI information systems to assist in task execution, in addition to considering the factors of task and technology, they should significantly strengthen the self-efficacy of teachers' AI-supported teaching applications to facilitate mutual adjustment between teachers, tasks and technology, thereby improving teachers' teaching performance. The measurement tool developed in this research can reflect teachers' effectiveness evaluation in AI teaching, which has important implications for both theoretical research and the practical application of teacher self-efficacy.

Implication and future research and limitations

Implication

First, this research presents the AIS-TASE scale that can be used as a tool for teachers to judge themselves in AI-supported teaching. The measurement can reflect teachers' effectiveness evaluation in AI-supported teaching, which has important implications for theoretical research and practical application in emerging technology teaching. Second, this study's analysis of background variables found that gender, job position, teaching background, school attributes, and teachers' use of technology-instruction integration AI experience reflect differences in self-efficacy in AI-supported teaching. The scale can be used for vocational education to evaluate teachers' AI-supported teaching competence.

Future research

First, the factor analysis results of this study found that AIS-TASE includes five factors, of which "adherence to hard work" and "negative consciousness" are self-contained factors for hostile questions. This finding is different from other research results; it shows that the response form of negative questions has a specific cognitive mechanism, which is worthy of further research. Future research can further explore the question of whether method effects exist in negative questions. Second, the relationship between self-efficacy in AI-supported teaching and teaching experience is insignificant. Future research can also continue to explore the impact of AIS-TASE on teachers' AI-supported teaching behaviour and construct an overall model of AIS-TASE. Third, among the many innovative applications of AI in education, the emergence of Chat Generative has attracted widespread attention. Teachers can use ChatGPT as an AI-supported teaching tool. ChatGPT uses natural language models to increase student's access to learning information, generate reasonable answers, promote students' self-improvement capabilities, provide personalised and real-time feedback, and reduce teachers' teaching workload.

Limitations

First, because this scale scoring is based on teacher self-report questionnaires, attitudes, and emotions have an impact on the self-reports from which the data are gathered. As a result, the content of perception can change depending on teachers' location and time. Second, because high school vocational teachers make up the study's sample, findings from this research cannot be generalised to other subject levels. For example, primary school teachers' and college instructors' perceptions of the self-efficacy scale of AI-supported teaching applications may differ, and the research results cannot be inferred from other levels of objects.

Abbreviations

AI: Artificial intelligence; AIS-TASE: AI-supported teaching application self-efficacy; CFA: Confirmatory factor analysis; EFA: Exploratory factor analysis; LA: Learning analytics; TES: Teaching Efficacy Scale; TSE: Self-efficacy.

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Authors' contributions

Each author listed above has made substantial contributions (data collection, data analysis and interpretation, draft, major revision of the article, and final approval of the version to be released) to the conception, design of the study, manuscript or substantively revised it. The authors read and approved the final manuscript.

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Data will be made available on reasonable request.

Declarations

Competing interests
The authors declare that they have no competing interests.

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