The Construction of Artificial Intelligence Deep Learning Ability Indicators for Vocational High School Students

Chih-Cheng Tsai, Tsai-Feng Cheng, Ru-Chu Shih and Shi-Jer Lou*

Abstract**—**How to plan elective courses according to 108-Courses to make them features of a school has filtered in every educational institute in Taiwan. In response to industry 4.0, artificial intelligence (AI) has become more prominent in science and technology. Therefore, researchers have developed "Artificial Intelligence Deep Learning Ability Indicators for Vocational High School Students" in response to the implementation of optional courses in 108-Courses and the rise of AI. In this study, "Artificial Intelligence Deep Learning Ability Indicators for Vocational High School Students" integrates expert opinions from a survey with the Triangular Fuzzy Number of Fuzzy Delphi method, conducts analysis of defuzzification values by writing grammatical instructions with IBM SPSS Statistics software, and then uses the defuzzification value of 0.6 as the standard for the screening threshold. The results are as follows. The results of this study are as follows. 1. The defuzzification values of each ability dimension are all higher than the threshold value (.6), indicating that "recognizing AI", "basic computing ability", "AI structure", and "AI application" can be used as the ability dimensions of AI deep learning. 2. The defuzzification values of the ability indicators of each ability dimension are all higher than the threshold value (.6), indicating that all ability indicators are very suitable for AI deep learning. 3. The key points of each ability indicator are all higher than the threshold (.6), and all 58 key points meet the experts' recognition, showing that the questionnaire of this study is complete and appropriate and can be used as artificial intelligence deep learning ability indicators for vocational high school students. The suggestions are as follows. According to the situation of each school and the degree of students, some suitable courses and ability indicators can be selected and flexibly integrated and applied based on the development history of AI, prepared knowledge, application situation, etc.

Keywords**—**AI, deep learning, ability indicators, 108-Courses

I. Introduction

Taiwan's 108-Courses program is about to be implemented nationwide, and the number of optional courses in vocational schools will increase dramatically. How to plan courses to meet the needs of students' future vertical studies or horizontal employment, to make them featured courses of schools, and to attract students' willingness to study has become an urgent task. In order to enhance their competitiveness, all countries have oriented current international trade to AI development, and the trend is also towards science and technology, but there are few AI deep learning courses among available courses offered by Taiwan's Vocational High School Group Course Information Network. It is thus a concern whether Taiwanese students will fall behind in the future science and technology arena. In the face of the 108-Courses reform, should schools be based on teachers or students when planning optional courses? The above questions are worth discussing. As the 108-Courses has added "AI deep learning" and other optional courses, if one can take students' learning as the orientation, then it will not only enhance their knowledge and ability in the field of information technology, but also make the courses become featured courses of a school, thus attracting more students' willingness to choose a school and to study there. Therefore, this study aims to provide a basis framework for schools when planning relevant courses with "construction of artificial intelligence deep learning ability indicators for vocational high school students".

A. Research Background and Motives

The Ministry of Education has put forward the overall implementation strategy for AI and emerging science and technology education. All education levels including elementary schools, junior high schools, senior high schools, and universities need to participate in AI learning. In the AI education stage of primary and secondary schools, through cooperative development among university professors and primary and secondary school teachers on supplementary teaching material, "Making Friends with AI", and with the topics of the most important core technologies of machine learning and deep learning in AI, the demonstration of AI teaching materials and lesson plans for elementary schools, junior high schools, and senior high schools have been completed and provided to interested teachers and students for reference . Although the Ministry of Education [1] has devoted a lot of effort toward AI education and courses in primary and secondary schools, schools have long already entered the stage of preparation and book selection for the optional courses to be implemented in the 108-schoolyear. Therefore, the teaching materials and lesson plans for AI education in primary and secondary schools of the Ministry of Education are very likely to be too late to meet the needs of schools.

Liu and Hung (2013) pointed out that in the past, when schools planned optional courses, teachers' expertise and willingness were often given priority rather than students' needs or industry trends. Such learning planning led to a significant

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gap between the professional knowledge learned and the actual industrial environment, which not only made students unable to apply practically what they learned, but also increased the burden of firms' HR re-training in various industries. In response to the coming of Industrial 4.0, AI has become the prominent target for emerging sciences and technologies. Therefore, schools should not only follow the spirit of optional courses of 108-Courses, but also keep up with the current industrial demand and trends.

[2] "Ability indicator" is a noun originally created in Taiwan. From the perspective of educational indicator, it is similar to the content standard and performance standard of various disciplines in the U.S. Its concept is similar to Japan's learning guidelines (course standards), Australia's Key Competency (KC), etc. The functions of the indicators include the basis for developing teaching materials, the medium of communication, the criteria of quantity, the standard for evaluation, and benchmarks for proficiency tests, which are used to present the learning results that students should have after going through the learning process.

In response to the implementation of the optional courses of 108-Courses and the trend of AI, the researchers designed "artificial intelligence deep learning ability indicators for vocational high school students" based on relevant literature to suit the learning indicators for Taiwanese vocational high school students learning AI courses and to serve as the basis for an AI deep learning course model.

B. Research Questions

The purpose of this study is to explore the artificial intelligence deep learning ability indicators and construct teaching and learning indicators suitable for vocational school students' AI deep learning. The research questions are as follows.

(1) What are the ability dimensions of artificial intelligence deep learning ability indicators for vocational high school students? (2) What are the ability indicators of artificial intelligence deep learning ability indicators for vocational high school students? And (3) What are the key points of artificial intelligence deep learning ability indicators for vocational high school students?

C. Research Purpose

Based on the literature and related research of AI deep learning, this study analyzes the appropriateness of AI ability indicators with the Fuzzy Delphi method and aims to construct AI deep teaching and learning indicators suitable for vocational high school students, so as to serve as the basis for developing Taiwan's course model and further cultivate students who can apply what they have learned to real-world practice. The research objectives are as follows.

(1) To explore the ability dimensions of artificial intelligence deep learning ability indicators for vocational high school students. (2) To explore the ability indicators of artificial intelligence deep learning ability indicators for vocational high school students, and (3) To explore the key points of artificial intelligence deep learning ability indicators for vocational high school students.

II. Research Method

A. Research Subjects

In order to make the ability indicators drawn up in this study more representative, complete, and effective, and to be applicable to the selection of textbooks for optional courses in vocational high schools, all experts invited were professors from science and technology universities and teachers from vocational high schools with rich experience in information teaching or relevant practical work experience. Their background information is shown in Table 1.

Table I Expert background

Title	Service unit	Expertise	Remarks
Professor	Department of Electrical Engineering, National Kaohsiung University of Science and Technology	Image recognition	Former R&D Consultant of Science and Technology Company
Assistant Professor	Department of Mechanical Engineering, National Pingtung University of Science and Technology	Image recognition	Former IBM Engineer
Distinguished Professor	Shu-Te University	Image recognition	Former Consultant of Science and Technology Company
Teacher and Department Directors	Data Processing Department, Kaohsiung Municipal San-Min Home Economics & Commerce Vocational High School	Image Recognition, Speech Recognition, Video Recognition, Natural Language Processing	Former Engineer of Science and Technology Company
Teacher and Team Leader	Data Processing Department, Kaohsiung Municipal San-Min Home Economics & Commerce Vocational High School	Image recognition	Former Semiconductor Engineer

B. Research Tools

The term "AI" was put forward at a symposium held in Dartmouth in 1956. It has experienced three great trends and fell to a low point each time due to some technical difficulties that could not be overcome (Chu, 2018). In recent years, AI has flourished again. The key points lie in data, algorithms,

computing systems, etc. AI is a multi-disciplinary cross-cutting field, including philosophy, mathematics, economics, neuroscience, psychology, computer engineering, linguistics, etc. It is often accompanied by algorithms that have a wide range of application levels (Domingos, 2015). Therefore, after sorting out and analyzing the relevant literature on AI deep learning, this study screens the common application level as a preliminary construction of ability indicators, such as Table 2.

TABLE II APPLICATION LEVEL AND CLASSIFICATION OF AI DEEP LEARNING

	Voice ID	Image ID	Natural Language Processing	Machine Learning	Video ID	Forecast Analysis	OP Plat.	Emo ID
Ho (2017)	✓	✓	✓	✓	✓	✓	✓	
Cockburn, Henderson & Stern (2018)	✓	✓	✓					✓
Foxconn Education Foundation (2019)	✓	✓	✓		✓			
Huimin, Yujie, Min, Hyoungseop, Seiichi (2018)	✓	✓	✓	✓				
Amazon AI	✓	✓	✓		✓			

Based on the common application level of the above table, the basic knowledge of AI and the required mathematical preparation knowledge are integrated into the preliminary ability indicator framework in this study, and then the key points of each level are developed according to these indicators, such as in Figure 1.

AI Deep Learning Ability Indicators		
I. Recognition of AI	1. AI History	4 Indicators
	2. AI in Life	3 Indicators
II.Basic computing ability	1. Basic Concept of Vector	4 Indicators
	2. Basic Concept of Matrix	2 Indicators
	3. Basic Concept of Set	4 Indicators
III. AI structure"	1. Neural Network Concept	3 Indicators
	2. Neural Network Types	6 Indicators
IV. AI application	image recognition	7 Indicators
	voice recognition	8 Indicators
	video recognition	8 Indicators
	natural language processing	9 Indicators

Fig. 1 AI Ability Standard Framework

The experts' questionnaire of "AI Deep Learning Ability Indicators of Vocational High School" is constructed from the indicators developed at all levels, and inappropriate key points are deleted according to their opinions.

C. Data Analysis

Compared with the traditional Delphi method and statistical method, it is often limited by the single value of statistics and cannot express the complexity of human thinking and subjective meaning [4]. The Fuzzy Delphi method can make up for the deficiencies of the traditional Delphi method and statistical method. It can also process semantic ambiguity, retain more expert information, and fully express personal opinions and the opinions of each expert. It has the advantages of the same value and is not limited by the influence of personal power. In this study, triangular fuzzy number is used to integrate the opinions of many experts. Only one survey is needed, which not only reduces the cost, but also expresses the fuzziness and uncertainty of human thinking, thus increasing the objectivity of the scale[5] [6]. Reference is made to the semantic transformation of [7], and it is transformed into a system with relevant fuzzy numbers. The third level in the semantic table in the system is then used to convert the relevant weights of semantic transformation of all experts into corresponding weight triangular fuzzy numbers and to quantify the defuzzification method, so as to achieve the purpose of evaluation. The total value of triangular fuzzy numbers of the indicators is used to screen the key points of the ability indicators, such as in Table 3. This study integrated experts' opinions with triangular fuzzy numbers of the Fuzzy Delphi method as the survey, and the defuzzification values are analyzed with grammar instructions written by IBM SPSS Statistics software. Since 0.5 is in the middle between 0 and 1, which represents the common value considered important and somewhat unimportant by experts, the defuzzification value of 0.6 is selected as the basis for the screening threshold.

TABLE III WEIGHT SEMANTIC VARIABLES AND TRIANGULAR FUZZY NUMBER CONTRAST TABLE

Weight Semantic Variables	Triangular Fuzzy Number
Very low (VL)	(0, 0, 0.25)
Low (L)	(0, 0.25, 0.5)
Middle (M)	(0.25, 0.5, 0.75)
High (H)	(0.5, 0.75, 1)
Very high (VH)	(0.5, 0.75, 1)

D. Research Process

The process of this study is shown in Figure 2. In order to meet the knowledge ability in the field of information and technology of 108-Courses and to connect university courses vertically and link with technological talents needed by industry horizontally, the optional featured courses of vocational high schools are developed as the theme of this study. After determining the theme, the data analysis of relevant documents is conducted to sum up the application level of AI deep learning in vocational high schools - namely, the ability indicator dimensions of this questionnaire. The questionnaire adopts the Likert Five-Point Scale, which converts the opinions expressed by each expert into triangular fuzzy numbers by using the semantic variables of the Fuzzy Delphi method. Finally, the grammatical program of statistical software SPSS is written to calculate the defuzzification values at all levels to screen the levels of ability indicators.

III. RESULTS

Aiming at the indicators of "recognition of AI", "basic computing ability", "AI structure", and "AI application", this paper carries out the defuzzification values of expert questionnaires, takes the observation values as the benchmark, and then decides whether to delete the factors according to the threshold value (0.6) determined by purpose of this study. The results are as follows.

1. The defuzzification value of each ability dimension: recognition of AI (.832), basic computing ability (.771), AI structure (.778), and AI application (.731) are all higher than the threshold value (.6). 2. The ability indicators of each ability dimension are also higher than the threshold value (.6):

(1) For ability indicators of recognizing AI, the defuzzification values of each secondary ability indicators are AI history (.775) and AI in life (.737). (2) For ability indicators of basic computing capability, the defuzzification values of each secondary ability indicators are vector basic concept (.848), matrix basic concept (.695), and set basic concept (.678). (3) For ability indicators of AI structure, the defuzzification values of each secondary ability indicators are neural network concept (.787) and neural network type (.769). (4) For ability indicators of AI application, the defuzzification values of each secondary ability indicators are image recognition (.735), voice recognition (.746), video recognition (.713), and natural language processing (.731). 3. The key points of each ability indicator are all higher than the threshold value (.6).

IV. CONCLUSIONS AND SUGGESTIONS

According to the research results and comprehensive expert opinions, the conclusions and suggestions are as follows.

(1) The defuzzification values of each ability dimension are all higher than the threshold value (.6), showing that "recognizing AI", "basic computing ability", "AI structure", and "AI application" can be regarded as the ability dimensions of AI deep learning. (2) The defuzzification values of the ability indicators of each ability dimension are higher than the threshold value (.6), which shows that the ability indicators are very suitable for AI deep learning. It is worth mentioning that the defuzzification value of "AI in life" in "recognizing AI" is the highest (.832), indicating that experts agree that students can understand that AI deep learning has been widely applied in daily life, rather than just remote science fiction. The "basic concepts of vectors" (.848) in the "basic computing ability" indicates that AI deep learning needs the prior knowledge of basic mathematical concepts, such as vectors, so as to understand the computing process of the course content. (3) The key points of all ability indicators are higher than the threshold (.6), and the 58 key points of ability indicators have reached the experts' approval. This shows that the questionnaire in this study is complete and appropriate and can be used as AI deep learning ability indicators for vocational high schools.

All the ability indicators in this study have been approved by all experts, but some suggestions have also been put forward.

(1) When planning the optional courses of vocational high schools in each semester, each school has its own practice and number of courses. Therefore, for the relevant courses in "AI deep learning", some suitable courses and ability indicators can be selected as teaching contents depending on the actual situation of each school and the students' learning level. (2) When planning the courses related to "AI deep learning", flexible integration and application can be carried out according to different aspects of AI's development history, knowledge, and application situation. (3) Teachers who teach "AI deep learning" should take part in relevant studies or public and private trainings after school or during summer vacation to enrich their knowledge of AI and other related abilities and skills when their professional abilities are insufficient. (4) Teachers who are interested in "AI deep learning" can set up professional communities of teachers to communicate and share with each other in order to improve their professional ability, understand students' needs, or develop their teaching models.

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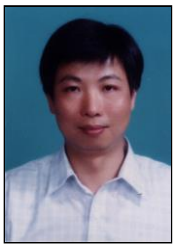

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