

# Literature review of Pre-service Teachers' (PSTs) Training in Teaching Artificial Intelligence (AI)

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## Abstract

At present, artificial intelligence education has been attached importance to by various countries. Equipping citizens with AI literacy is one of the educational goals of many countries. In the process of developing artificial intelligence education, the ability of teachers plays a very important role. How to train artificial intelligence teachers is an important topic of academic attention. However, there is little literature review on this topic. Therefore, this study mainly focuses on artificial intelligence training for pre-service teachers. The content of this study mainly includes.

## Keywords

Pre-service teachers; Artificial intelligence; Teachers' (PSTs) Training.

## 1. Overview of Pre-service Teachers' (PSTs) Training in Teaching Artificial Intelligence (AI)

Many countries have taken initiatives to introduce artificial intelligence (AI) subjects in their pre-service teachers' (PSTs) training and primary school classroom because inevitably, the current work of PSTs and the future study of students will be closely related to AI. Especially in China, the government and schools have attached great importance to the introduction of AI subjects in schools. As AI is a new subject, the PSTs' traditional training methods can no longer meet the needs of PSTs and primary school students. Moreover, as a teacher, it is a challenge as well as an opportunity to use appropriate methods to teach their students AI, which calls for a reflection on how to best train and educate teachers to teach AI to students (Stefania, 2018).

First and foremost, for pre-service teachers (PSTs) and students who know little about artificial intelligence (AI), it is a challenge to understand the its concepts and knowledge without appropriate platforms or tools. Without the operation of actual technical tools or platforms, it is difficult for PSTs and students to understand the concepts and meanings related to AI subjects (Brandes & Armoni, 2019), such as how computers recognise images and texts. In order to solve this problem, Stefania (2018) developed the Cognimates platform to help teachers understand AI concepts and use this platform to teach their students. Other platforms that make AI accessible to teachers and younger students have also been developed by different companies or researchers, for example, Machine Learning for Kids, Cozmo robot, AI experiments (Google), Google's AIY (AI and You) and TensorFlow Playground (Thomas, 2018; Touretzky et al., 2019). These provide teachers with opportunities to learn AI technology and develop their own AI curriculum. For students, they are able to think with AI and create AI projects and models by themselves.

Secondly, it is important to identify what content teachers should teach to students in each grade band. It is difficult to determine the teaching content of artificial intelligence (AI) because it is a broad and complex concept. Some researchers prefer the traditional division of teaching content into application filed (Martin & Chiang, 2010), such as speech, vision, planning, game playing, natural language, and robotics. However, this traditional division did not meet the needs of teachers or students. Hence, Touretzky et al. (2019) put forward five "Big Ideas," which

is shown in the following; computers perceive the world using sensors; agents maintain models/representations of the world and use them for reasoning; computers can learn from data; the interaction between agents and humans; AI applications can have its impact on society in both positive and negative ways. They believed that the five "Big Ideas" are easy to implement in the AI curriculum design, meanwhile it can make students learn the landscape of AI. These provide teachers who want to introduce AI into the curriculum an opportunity to practise their ideas with the guidance of the five "Big Ideas."

Thirdly, it is a challenge for teachers to understand how to teach students artificial intelligence (AI). In other words, before carrying out the AI curriculum, teachers should possess the teaching method of AI. Holmes et al. (2019) proposed a new AI teaching and learning framework, which breaks educational goals into four aspects; knowledge (what we know and understand), skills (what we can do with what we know), character (how we behave and engage in the world) and meta-Learning (how we reflect and adapt). This framework can be used to guide teachers teaching students AI, and provide an opportunity to make teachers develop their own teaching method. Although some useful insights can be drawn from this framework, it is not designed for the pre-service teachers (PSTs) training.

Last but not least, some researchers focused on the teachers' training module to teach artificial intelligence (AI) to primary and secondary school. For example, Heinze et al. (2010) study identified that a collaborative effort between teachers and AI researchers is an important strategy for teacher training, which provide a three-year curriculum including basic AI concepts, AI vocabulary, and the history of AI. Some scholars emphasised that AI researchers should collaborate with teachers who have extensive teaching experience (Sabuncuoglu, 2020). Collaborative type is defined as a way teachers work together on an on-going basis, and the beneficial training module (Cordingley et al., 2003). The community of practice type requires teachers to work together towards a common goal and share their experiences (Wenger, 2010). While Vazhayil et al. (2019) argued that peer teaching, application of prior knowledge, and community engagement are effective strategies for teacher training for teach AI subject, which can promote teachers' motivation, beliefs, and practices. Therefore, it can be concluded that teachers' training in AI teaching should promote teachers' initiatives through the integration of teacher training and community practice while strengthening their teamwork in the process. In the context of China, the modules used for in-service teacher training to teach AI include four main types; (1) A few experienced key teachers are trained first in primary and secondary schools through teaching and research activities, and then a group of qualified teachers for AI courses are further groomed by these teachers (2) Primary and secondary schools use "national training", "provincial training", "academic upgrading" and other teacher training programmes at all levels to improve teachers' teaching ability in teaching AI (3) Primary and secondary schools cooperate with universities to improve teachers' teaching ability (4) Primary and secondary schools cooperate with enterprises to train AI teachers (Qingshun, 2020; Zhongxin et al., 2019). However, the current training model for PSTs of AI education has not yet been developed in Chinese universities. The above discussion has inevitably shown that although there have been studies focusing on how trained teachers teach AI to students, there is limited research introducing service-learning module in training PSTs to teach primary school students AI subjects.

## **2. Pre-service Teachers' (PSTs) Training in Teaching Artificial Intelligence (AI) and Their Practical Knowledge**

When discussing pre-service teachers (PSTs) training in teaching artificial intelligence (AI), one of the main issues is the knowledge that PSTs should possess. Shulman (1987) and Wilson (2009) suggested that teachers' knowledge is divided into several categories; content

knowledge, knowledge of other content, knowledge of learners, knowledge of educational aims, and general pedagogical knowledge. The American Computer Science Teachers Association pointed out that teachers must acquire subject matter knowledge and teaching skills to enable them to present the material to students at the appropriate level (Tucker et al., 2004). Generally, PSTs training of AI are embedded with fundamental theories of computer science, programming concepts and languages, common algorithms, data structures (Qian & Lehman, 2018), as well as AI knowledge and practical knowledge (Ragonis et al., 2010).

Further to this, Zhao & Liu (2018) emphasised that teaching and learning would develop in the direction of pre-service teachers' (PSTs) knowledge in the artificial intelligence (AI) education field. They believed that PSTs should master AI teaching content knowledge and grasp the following three aspects; to cultivate students' interests, attitudes and methods in exploring knowledge; to cultivate students' good conduct; to inspire students to find life value and meaning. Similar research viewpoints proposed by Druga (2018) is that the pedagogical knowledge of the PSTs should be used to help students learn and understand AI concepts. She emphasised that teachers should provide students with meaningful feedback on each action, and should encourage students' reflection and collaboration in the process of sharing and modifying one another's AI projects and models. Therefore, it can be concurred that the knowle Having reviewed previous studies, it can be stated that researchers have different views on what kind of knowledge pre-service teachers (PSTs) should possess. However, many researchers believed that PSTs' knowledge formed in practice has a significant influence on teachers' behaviours in the classroom (Ragonis et al., 2010; Shulman, 1987; Wilson et al., 1987). Therefore, the PSTs training in artificial intelligence (AI) teaching should focus on methods and practicum. The methods are mostly related to the school curriculum, pedagogy, content, and practical knowledge (Hazzan & Lapidot, 2004). Meanwhile, practicum strengthens the relationship between the research theory and the practice, between the university tutor and the school tutor, and between the method curriculum and the actual situation (Hazzan & Lapidot, 2004). Besides that, integrating social issues such as ethics, diversity, and history into method learning is also important for PSTs training (Hazzan & Lapidot, 2006).

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A distinctive feature of pre-service teachers (PSTs) training in artificial intelligence (AI) teaching is that the teachers' practical knowledge, skills and ability come from practical work or hands-on activities, and they form practical wisdom through reflection and then apply it in practice (Abrahams & Millar, 2008; Armoni, 2011; Vazhayil et al., 2019). Long & Magerko (2020) argued that PSTs training is a process of integrating practical activities and theoretical knowledge. The theoretical knowledge should include social and psychological foundations – PSTs should be familiar with the stated foundations and use them in a broader context (Pietig, 1997). Hence, PSTs training also should include practical experience. Beth et al. (2015) recommended that when selecting and training PSTs, the training module should focus on their strengths rather than their weaknesses; in order to promote best practices and create a hierarchical support system. They also recommended that the training module design should

pay attention to the classroom environment. Moreover, Jaworski & Gellert (2003) argued that practical activity could get inspiration and experience from the reflection on theory. Reflection is necessary for teacher training and is considered as a meta-cognitive and a characteristic of higher-order thinking (Cooney & Wiegel, 2003; Damon, 1987). The goal of reflection is to enable PSTs to become active learners and to continuously evaluate, apply and improve knowledge throughout their professional development. Hence, the present study contends that PSTs training is a process of connecting teachers' theoretical knowledge with their practical experience to increase teachers' knowledge acquisition.

### **3. Pre-service Teachers' (PSTs) Training in Teaching Artificial Intelligence (AI) and Their Motivation**

The motivation variable is significant within the realms of artificial intelligence (AI). The consensus of most studies is that mastering the relevant knowledge of AI courses is of great significance to pre-service teachers (PSTs). However, their motivation towards AI is low. Due to the lack of practical teaching cases of AI courses in primary schools, it is difficult for PSTs to gain indirect experience from the cases (Lu et al., 2021). At the same time, the design of the PSTs' training model has an important influence on motivation. Many studies argued that the design of the training module for PSTs should first consider motivation, which should enable PSTs to gain a sense of accomplishment and self-efficacy in experience, form educational beliefs, and maintain sustainable motivation (Bruster & Barry 2020; Wang & Zhang, 2021). Additionally, another factor that affects PSTs' motivation is the extent to which university administrators place emphasis in AI education courses. Some scholars clearly pointed out that most colleges and universities have not paid enough attention to the opening of AI courses (Li, 2021), resulting in fewer opportunities for PSTs to engage in AI courses.

Bin (2020) in his research emphasized that pre-service teachers (PSTs) training cannot leave the real world and educational context. This helps them to obtain real experience, emotions, sense of accomplishment, and meaning of learning. It is very important to inspire and maintain PSTs' motivation towards artificial intelligence (AI). In a more in-depth way, the PSTs' training module design should ensure an effective connection between the school learning and the education practice outside the school and integrate the two into a whole in the four aspects of teaching; objectives, content, tools and methods. Some researchers believed that the key success factor for the effective connection between the PSTs' on-campus learning and the off-campus educational practice lies in the establishment of a practice community, which includes three main bodies; the PSTs, university tutors, and in-service teachers (Zhang et al., 2021). In other words, this PSTs training module requires that both university tutors and in-service teachers are PSTs teachers, and they work together to help PSTs complete their learning tasks.

From the discussion mentioned above, previous studies focus on the pre-service teachers (PSTs) training module platforms or tools, training content and strategies, as well as PSTs' practical knowledge and motivation towards AI. The researcher also concluded that PSTs training in artificial intelligence (AI) teaching is a practical process of integrating theoretical knowledge with community practical experience, which also provides PSTs with tools to continue their professional development as serving teachers. Meanwhile, reflection, real-life examples, hands-on activities and teamwork also play an essential role in the process of PSTs training in teaching AI (Hazzan & Lapidot, 2004; Lee & Williams, 2020). However, very few studies have introduced service-learning modules to the PSTs' training in AI teaching. At the same time, the importance of PSTs' practical knowledge and motivation has been mentioned in the relevant research on PSTs training. However, very limited research examined the effects of service-learning modules on PSTs' practical knowledge and motivation. In order to fill this gap, this research developed

a service- learning module to train PSTs to teach AI to primary school students, and verified the effects of the module on their practical knowledge and motivation.

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