# Improvement of Pre-Service Teachers' Practical Knowledge and Motivation about Artificial Intelligence through a Service-learning-based Module in Guizhou, China: A Quasi-Experimental Study

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**Abstract.** The purpose of this study is twofold: 1) to develop a service-learning-based module training artificial intelligence (AI) subject (SLBM-TAIS), and 2) to evaluate the effect of SLBM-TAIS on pre-service teachers' (PSTs') practical knowledge and motivation, as well as primary school students' attitude towards AI in China. Participants of this study comprised 60 PSTs and 107 primary school students. The experimental research in this study followed the quasi-experimental non-randomized pre-test and post-test control group design. The PSTs were divided into experimental and control groups, and the primary school students followed the same grouping. The PSTs in the experimental group taught AI subjects to the primary school students in the experimental group, while the PSTs in the control group taught AI subjects to the primary school students in the control group. The results of the study showed that SLBM-TAIS was effective in training PSTs to teach AI subjects to primary school students. Furthermore, the SLBM-TAIS developed in this study offered a unique technique for training PSTs and primary school students that could increase PSTs' practical knowledge and motivation, as well as primary school students' attitudes toward AI. The findings from this study are important in the field of educational psychology, and its contribution has several theoretical and practical implications.

**Keywords:** Attitude; artificial intelligence; pre-service teachers; primary school students; practical knowledge; motivation

## 1. Introduction

As AI continues to rapidly permeate consumer goods, playthings, as well as various smart technologies, it becomes necessary for people from all walks of life, specifically the current youth, to develop a deeper understanding of it. To comprehend AI in a resourceful way, AI education involving meaningful engagement with this technology is the way to go. Although governments and researchers have been concerned about the use of AI in education and how it reflects a relatively young era of

education (Roll & Wylie, 2016), many countries, such as China, have rushed to incorporate AI subjects into their educational curricula. Given this, China's State Council has drawn up A Next-Generation Artificial Intelligence Development Plan as a framework to seek every strategic opportunity AI has to offer (State Council of China, 2017). However, as stated by Yang (2019), the new generation of Chinese lacks a grasp of tackling new technologies. One of their main concerns is the low sufficiency of technological competencies, in terms of new knowledge acquisition and skills development, to adapt to world-changing living landscapes. Advances in ubiquitous AI applications compel the amendment of the curriculum so that new technical skills can be included. This farsighted approach will prepare the current younger generation for a high-tech future (Touretzky et al., 2019). Thus, educational researchers have commenced studies that involve the use of AI in educators' training approaches (Mohammed, 2019; Wahat & Hamid, 2018). However, professional training for teachers on AI is still limited, and the introduction of AI subjects into primary education is still at its infancy stage (Burgsteiner et al., 2016). Pre-service teachers (PSTs) find it challenging to apply appropriate training modules to teach AI to their students. In the Chinese educational context, the government has issued important education policies to encourage teachers to actively adapt and teach AI to primary school students. However, due to the continuous expansion of the AI market scale and the deepening of its application, there is a serious shortage of knowledgeable and motivated teachers, especially in primary schools (Sales, 2019). According to the study of Lizhen et al. (2019), only 35% of Chinese teachers in primary schools are qualified to conduct AI-related courses as primary education is the incubator for the next generation of leaders, thinkers, and innovators. This situation highlights that trainings for PSTs in terms of practical knowledge and motivation in teaching AI are still lagging behind socio-economic development and market demand. This inherently affects their attitude towards AI (Mingxi & Yunpeng, 2018).

Despite the excellent intentions, the traditional teaching methods used to enhance PSTs' practical knowledge and motivation, as well as their students' attitude towards AI, were initially ineffective in China (Dong et al., 2020). Thus, it has always been difficult for the trained PSTs to meet the requirements of society and schools. Most Chinese PSTs in educational faculties are not highly motivated and their positive motivation towards technology lacks due to their poor background and interest in technology (Hue & Ab Jalil, 2013; Keller, 2009). Besides, the current promotion of AI subjects in primary schools and its impacts on the students' attitudes are not commonly studied. As such, this research focuses on attitude investigations. Various researches in China have proven that the positive attitude of students towards technology declines as they grow (Afshari et al., 2009; Lianzhen & Shiji, 2018), possibly due to the lack of attention, core competence (*hexin suyang*), and uninterested teachers in novel subjects (Li & Ni, 2012).

An existing research gap is that there are currently no studies on the application of service-learning theory incorporated in AI training modules for PSTs to improve their motivation. Therefore, this research is expected to design a service-learning-based module training AI subjects (SLBM-TAIS) for PSTs, to examine its effect on their knowledge and motivation as well as students' attitude as the main beneficiaries, and to compare the results with the traditional module of teacher training programs. As stated by Ardies et al. (2012), most technology courses do not relate to the real lives of primary school students. SLBM-TAIS is used to train teachers to teach AI subjects to primary school students.

## 2. Literature Review

Despite reformation efforts that advocate student-centered constructivist teaching in China, teachers still heavily rely on pedagogies that are more traditional at all levels. In other words, the old and traditional teaching approach, where the teacher talks and the students listen, continues to dominate the teaching process in China's education system. The traditional teaching approach is a direct instructional strategy in which the teacher is the major provider of information and his/her role is to pass facts, rules, or action sequences in the most straightforward way. This usually takes the form of lectures consisting of explanations and examples (Postareff et al., 2008). In traditional learning environments today, teachers continue to direct and lead instructions following structured lesson plans. In traditional lessons, skills are taught sequentially where lower-level skills are "mastered" before students are allowed to participate in higher-level activities that involve evaluation, synthesis, or analysis.

Unlike the traditional method, service-learning focuses on learning and developing competencies via community service in which genuine concerns are solved to deliver real-world solutions. Many researchers have introduced the service-learning theory to PSTs' training (e.g., Kula, 2021). Service-learning is a method of experiential education where the knowledge or teaching skills that PSTs learn in classes can be applied to real-world problems and real-world needs (Pereira & Costa, 2019). It is often used to provide teachers with opportunities to confront challenges in complex natural contexts and to help teachers gain practical knowledge and teaching strategies that are transferable to new situations. Moreover, one of the main objectives of service-learning is to increase the motivation of technology teachers by enabling them to design educational activities that cater to the various strengths, needs, and interests of their students (Chambers & Lavery, 2017). Research on training modules for teachers in AI subjects should focus on the development of PSTs' practical knowledge, which is practical, personal, and experiential. In China's context, these training modules in technology-related disciplines focus on providing PSTs with the opportunity to participate in real teaching situations, reflect on their motivation to become teachers, and generate personal practical knowledge. However, very few studies have focused on the AI discipline. Meanwhile, most of the previous studies utilized qualitative research methods to explore teachers' practical knowledge. By evaluating the hypotheses listed below, the quasi-experimental research approach was used for this study:

**$H_1$.** *There are no significant differences in PSTs' practical knowledge between…*

- **$H_{1a}$** … experimental group and control group before the intervention.
- **$H_{1b}$** … pre-test and post-test in the control group.
- **$H_{1c}$** … pre-test and post-test in the experimental group.
- **$H_{1d}$** … experimental group and control group post-test.

In terms of the relationship between teachers' training and motivation, most research on teachers' motivation in China has mainly focused on teachers' professional motivation, teaching motivation, and achievement. Some have also conducted quantitative research on the relationship between training and motivation of technology teachers. However, there are very limited studies on the relationship between PSTs' training and their teaching motivation (Mahler et al., 2018). Thus, using the quasi-experimental research method, the following hypotheses were tested:

**$H_2$.** *There are no significant differences in PSTs motivation between…*

- **$H_{2a}$** … experimental group and control group before the intervention.
- **$H_{2b}$** … pre-test and post-test in the control group.
- **$H_{2c}$** … pre-test and post-test in the experimental group.
- **$H_{2d}$** … experimental group and control group post-test.

Regarding students' attitudes towards AI-related subjects, many studies have found that students' attitudes towards technology are related to gender, curriculum structure, and teachers' teaching methods (e.g., Dukhan et al., 2008). However, PSTs' education and primary school curriculum in China focus on students' attitudes towards computer science generally, and not AI specifically. Thus, the hypotheses below were developed and tested:

**$H_3$.** *There are no significant differences in primary school students' attitudes between…*

- **$H_{3a}$** … experimental group and control group before the intervention.
- **$H_{3b}$** … pre-test and post-test in the control group.
- **$H_{3c}$** … pre-test and post-test in the experimental group.
- **$H_{3d}$** … experimental group and control group post-test.

## 2. Materials and Methods

### 2.1. Procedure

This study examined the effect of SLBM-TAIS on PSTs' practical knowledge and motivation, and potentially on students' attitudes. For the teaching content, five AI concepts were involved in the

SLBM-TAIS used in the present study: machine perception, representation and reasoning, machine learning, natural interaction, and societal impact. For this purpose, the experimental group accepted the SLBM-TAIS intervention, while the control group was taught using the educational practice training module (traditional module) as usual in their normal classrooms. Steps and related iterations and phases are presented in Table 1. Before using the instruments on a full-scale research project, the validity and reliability of each questionnaire used in this study were first tested. The Brislin back-translation method was used for the translation of the questionnaire from English to Chinese.

### 3.2 Sampling

Sixty PSTs (12 males and 48 females) and 107 primary school students in Grade 6 (50 males and 57 females) were involved in this study. A sample group of PSTs ($6^{th}$ semester, aged 20 or 21) from a university of the Guizhou province in China, which was chosen from 29 other universities by purposive sample, was used to study the PSTs' learning and teaching practice. Several factors were considered in the categorization process namely pre-test results, gender difference, similar teaching experience, and average academic performance. Since this research was simple with tight experimental control, about 30 participants were set in each group. The experimental group consisted of PSTs who learned how to teach AI concepts to primary students using SLBM-TAIS. The control group consisted of PSTs who learned how to teach AI concepts to primary students through the educational practice training module (traditional module).

**Table 1**. Research Design

| Step(s) | Iteration(s) | Phase(s) |
|---|---|---|
| 1 **Develop AI Training Module**<br>- Developed a SLBM-TAIS that includes six educational activities of preparation (team building, instructional design, implementation, demonstration, and reflection) for PSTs and their students. | - Improve the usability and content validity of SLBM-TAIS, which is evaluated by literature review. | **1. Reviewing Literature**<br>- Identify and design components of principles, content, tools, and process for developing SLBM-TAIS.<br>- Enhance PSTs' practical knowledge and motivation, and primary school students' attitude.<br>**2. Developing Module**<br>- Select any current resources, adapting, editing, and then adjusting these resources.<br>- Fit the manual of SLBM-TAIS to aid the manual development and creation process.<br>**3. Reviewing by Experts**<br>- Review as the main evaluation for content validity of SLBM-TAIS by expert feedback. |
| | - Verify the empirical validity of the first iteration' result.<br>- Examine the effect of SLBM-TAIS on PSTs' practical knowledge and motivation, as well as primary school students' attitude by using the quasi-experiment study. | **1. Module Implementation**<br>**2. Evaluation using quasi-experimental study** |
| 2 **PSTs Learning and Teaching Practice**<br>- University (7 weeks and 14 hours)<br>- Primary School (8 weeks and 19 hours) | - Complete the last and second steps.<br>- Conduct a quasi-experimental study (IV: AI training module; DVs: PTSs practical knowledge and motivation). | |
| 3 **Teaching Practice with Students Learning**<br>- Primary School (8 weeks and 19 hours) | - Teach school students AI concepts by the implementation of the instructional design by PSTs.<br>- Focus on the school students' attitude in the SLBM-TAIS.<br>- Help school students understand the knowledge of AI through hands-on activities.<br>- Determine the effect of the SLBM-TAIS on school students' attitudes toward AI by experimental study (IV: AI training module; DV: Students Attitude). | |

Note. Service-learning-based module training AI subject = SLBM-TAIS; Independent variable=IV; Dependent variable= DV.

### 3.3 Measurement

Three questionnaires on PSTs' practical knowledge and motivation and primary school students' attitudes were employed to determine the effect of SLBM-TAIS on these three psychological variables. The Practical Knowledge Acquisition questionnaire (PKA) of Jie (2016) with 36 items was used for this study to measure practical knowledge and the effect of the PSTs' training module on their practical knowledge acquisition. The sample item was "I can learn AI education knowledge". Each item was rated on a 5-point Likert scale ranging from 1 (never) to 5 (always). The Cronbach's alpha was 0.84. The Motivation towards AI questionnaire of Holland and Piper (2014) was used to measure PSTs' motivation. The Students' Attitude towards AI section was used to assess students' attitudes. The sample item was "I have inspiration while using AI". Each item was rated on a 5-point Likert scale ranging from 1 (never) to 5 (always). The Cronbach's alpha was 0.82. Ardies et al.'s (2012) questionnaire with 24 items was used to assess the attitude of primary school students towards AI. The sample item was "It is difficult for me to learn AI as a subject". All items were rated on a 5-point Likert scale ranging from 1 (never) to 5 (always). The Cronbach's alpha was 0.92.

### 3.4 Data Collection and Analysis

The survey data was collected before and after the intervention. All participants of the experimental and control groups were asked to complete the questionnaire twice: pre-test (one week before the intervention) and post-test (at the end of intervention). Data analysis included three stages: exploratory data analysis, descriptive data analysis, and inferential data analysis. For inferential analysis used to check the differences between the experimental and control group before and after the intervention, the Independent Samples t-test or the Mann-Whitney U test analysis was used to identify the differences between these two groups (Ong et al., 2021). The Paired Samples t-test or the Wilcoxon signed-rank test was conducted on the experimental and control group using SPSS 25.0 to determine whether there were significant differences in pre-test and post-test for PSTs' practical knowledge and motivation towards AI, as well as for primary school students' attitude towards AI.

## 4. Results

For small sample data, researchers tested the normal distribution of data using the one-sample Kolmogorov-Smirnov (K-S) test before comparing the differences between the experimental group and the control group before the intervention to select the appropriate analysis method (Scott & Harold, 2004). After the one-sample K-S test, the Z-statistics of practical knowledge in the experimental and control groups were 0.107 and 0.126, respectively. Meanwhile, the p-values for both groups at 0.200, which were greater than 0.05, showed normal distribution for the pre-test data. As such, the conditions for the Independent Samples t-test to compare and analyze the differences of practical knowledge between the experimental and control groups before the intervention were met (see Table 1). The Independent Samples t-test indicated no significant difference between the two groups before the intervention ($p > 0.05$). Thus, $H_{1a}$ was supported.

**Table 2.** Results of independent sample t-test analysis for practical knowledge between the experimental group and the control group before intervention

| Construct | | EG | | CG | | | | |
|---|---|---|---|---|---|---|---|---|
| Practical knowledge | | Mean | *SD* | Mean | *SD* | *t* | *df* | *p* |
| 1 | EB | 2.27 | 0.25 | 2.34 | 0.33 | -.996 | 63 | .323 |
| 2 | SK | 2.31 | 0.27 | 2.27 | 0.31 | .663 | 63 | .510 |
| 3 | SE | 2.33 | 0.32 | 2.38 | 0.37 | -.543 | 63 | .589 |
| 4 | IRK | 2.26 | 0.26 | 2.28 | 0.31 | -.263 | 63 | .794 |
| 5 | TSK | 2.30 | 0.31 | 2.37 | 0.33 | -.907 | 63 | .368 |
| 6 | SRK | 2.30 | 0.33 | 2.34 | 0.42 | -.380 | 63 | .705 |
| | Total | 2.30 | 0.21 | 2.33 | 0.25 | -.582 | 63 | .563 |

***Note***. Experimental group= EG; Control group= CG; Educational Beliefs= EB; Situational Knowledge= SK; Self-knowledge= SE; Interpersonal Relationship Knowledge= IRK; Teaching Strategies Knowledge= TSK; Self-reflection Knowledge= SRK.

The results of Z-statistics for the pre-test and post-test data on PSTs' practical knowledge of the control group were distributed normally (p-values were 0.200 and 0.001). Therefore, the Wilcoxon signed-rank test was used to compare and analyze PSTs' practical knowledge in the control group before and after the intervention. Further analysis of the six dimensions of practical knowledge found that there were no significant differences in PSTs pre-test and post-test (Table 2). However, there were significant differences in the two dimensions of situational knowledge (P = 0.000 < 0.05) and teaching strategy knowledge (p = 0.000 < 0.05). Moreover, the results indicated that the median for the post-test data (Mdn = 2.53), was statistically significantly higher than that of the pre-test data (Mdn = 2.39). The median difference value of 0.22 indicated that the median increase in PSTs' practical knowledge after the intervention was 0.22, showing that PSTs in the control group significantly improved their practical knowledge after using the educational practice training module. Thus, $H_{1b}$ was rejected.

**Table 3.** Results of Wilcoxon signed-rank test for practical knowledge between the pre-test and post-test in the control group

| Practical knowledge | | Negative Ranks | | | Positive Ranks | | | Test Statistics | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | N | Mean Rank | Sum of Ranks | N | Mean Rank | Sum of Ranks | Ties | Z | p |
| 1 | EB | 13 | 14.12 | 183.50 | 18 | 17.36 | 312.50 | 1 | -1.271 | .204 |
| 2 | SK | 0 | 0.00 | 0.00 | 32 | 16.50 | 528.00 | 0 | -4.959 | .000 |
| 3 | SE | 16 | 10.50 | 168.00 | 14 | 21.21 | 297.00 | 2 | -1.334 | .182 |
| 4 | IRK | 13 | 10.92 | 142.00 | 15 | 17.60 | 264.00 | 4 | -1.395 | .163 |
| 5 | TSK | 2 | 2.00 | 4.00 | 30 | 17.47 | 524.00 | 0 | -4.889 | .000 |
| 6 | SRK | 12 | 11.79 | 141.50 | 17 | 17.26 | 293.50 | 3 | -1.663 | .096 |
| | Total | 1 | 2.00 | 2.00 | 30 | 16.47 | 494.00 | 1 | -4.823 | .000 |

*Note*. Educational Beliefs= EB; Situational Knowledge= SK; Self-knowledge= SE; Interpersonal Relationship Knowledge= IRK; Teaching Strategies Knowledge= TSK; Self-reflection Knowledge= SRK.

For the experimental group, the one-sample K-S test showed that the Z-statistics for the pre-test and post-test data on PSTs' practical knowledge were 0.107 and 0.117, respectively, and the p-values for both data were 0.200, greater than 0.05. Therefore, the pre-test and post-test data of the experimental group were distributed normally, meeting the conditions of the Paired Sample t-test. There was a significant difference in the total scores of PSTs' practical knowledge in the experimental group before and after the intervention (P = 0.000 < 0.05) (see Table 3). Moreover, the level of practical knowledge after the intervention was higher than before the intervention ($M_{Post} = 3.19 > M_{Pre} = 2.30$), indicating that PSTs' practical knowledge in the experimental group was significantly improved after using the method of SLBM-TAIS. Thus, $H_{1c}$ was rejected.

**Table 4.** Paired sample t-test results for practical knowledge

| | Practical knowledge | Pre-Test Mean (*SD*) (n = 33) | Post-Test Mean (*SD*) (n = 33) | Mean Differences | *t* | *df* | *p* |
|---|---|---|---|---|---|---|---|
| 1 | EB | 2.27 (0.25) | 3.15 (0.39) | 0.88 | -14.058 | 32 | .000 |
| 2 | SK | 2.31 (0.27) | 3.25 (0.28) | 0.94 | -19.793 | 32 | .000 |
| 3 | SE | 2.33 (0.32) | 3.08 (0.32) | 0.75 | -13.635 | 32 | .000 |
| 4 | IRK | 2.26 (0.26) | 2.89 (0.50) | 0.63 | -7.671 | 32 | .000 |
| 5 | TSK | 2.30 (0.31) | 3.41 (0.23) | 1.11 | -21.042 | 32 | .000 |
| 6 | SRK | 2.30 (0.33) | 3.36 (0.21) | 1.06 | -21.775 | 32 | .000 |
| | Total | 2.30 (0.20) | 3.19 (0.14) | 0.89 | -24.974 | 32 | .000 |

*Note*. Educational Beliefs= EB; Situational Knowledge= SK; Self-knowledge= SE; Interpersonal Relationship Knowledge= IRK; Teaching Strategies Knowledge= TSK; Self-reflection Knowledge= SRK.

Since the previous one-sample K-S test showed that the control group's post-test data were not normally distributed, the Mann-Whitney U-test method was used to determine the differences in practical knowledge between the experimental group and the control group. The difference in the total scores of practical knowledge between the two groups was significant ($p < 0.01$) after the intervention. Moreover, the experimental group's median was statistically significantly higher than that of the control group ($Mdn_{EG} = 3.17 > Mdn_{CG} = 2.53$) (see Table 4), proving that SLBM-TAIS could improve PSTs' practical knowledge more than the educational practice training module. Further analysis of the six dimensions of practical knowledge showed no significant difference in situational knowledge between the experimental and control groups ($P = 0.559 > 0.05$). There were significant differences between the five dimensions of SLBM-TAIS and the educational practice training module. The findings showed significant differences in PSTs' practical knowledge between the experimental and control groups post-test. Therefore, $H_{1d}$ was rejected.

**Table 5.** Mann-Whitney U-test results of the differences between the experimental group and control group on practical knowledge after the intervention

| | | Median | | U | Z | P |
|---|---|---|---|---|---|---|
| | | EG | CG | | | |
| | Practical knowledge | | | | | |
| 1 | EB | 3.00 | 2.33 | 206.5 | -4.24 | .000 |
| 2 | SK | 3.17 | 3.25 | 484 | -.585 | .559 |
| 3 | SE | 3.00 | 2.50 | 196.5 | -4.374 | .000 |
| 4 | IRK | 2.83 | 2.33 | 294.5 | -3.076 | .002 |
| 5 | TSK | 3.50 | 3.17 | 278.5 | -3.335 | .001 |
| 6 | SRK | 3.33 | 2.25 | 110.5 | -5.53 | .000 |
| | Total | 3.17 | 2.53 | 188.5 | -4.46 | .000 |

*Note*. Experimental group= EG; Control group= CG; Educational Beliefs= EB; Situational Knowledge= SK; Self-knowledge= SE; Interpersonal Relationship Knowledge= IRK; Teaching Strategies Knowledge= TSK; Self-reflection Knowledge= SRK.

After the one-sample K-S test, the Z-statistics of motivation towards AI in the experimental and the control groups before the intervention were 0.088 and 0.192, respectively, and the p-values were 0.200 and 0.004, respectively. The control group's data were not distributed normally as the p-value was less than 0.05. Therefore, the Mann-Whitney U test was used. As shown in Table 5, the p-values of the three dimensions and the total scores of motivation towards AI in the two groups before the intervention were greater than 0.05. These results showed that there was no significant difference in PSTs' motivation towards AI between the experimental and control groups before the intervention. Thus, $H_{2a}$ was supported.

**Table 6.** Mann-Whitney U-test results of the differences between the experimental group and control group on motivation before intervention

| | | Median | | U | Z | P |
|---|---|---|---|---|---|---|
| | | EG | CG | | | |
| | Motivation | | | | | |
| 1 | AM | 2.50 | 2.50 | 493.0 | -.471 | .637 |
| 2 | IM | 4.00 | 3.80 | 515.5 | -.167 | .867 |
| 3 | EM | 3.67 | 3.83 | 426.0 | -1.371 | .170 |
| | Total | 3.54 | 3.54 | 480.5 | -.626 | .531 |

Note: Experimental group= EG; Control group= CG; Amotivation= AM; Intrinsic motivation = IM; Extrinsic motivation = EM.

According to the one-sample K-S test (Table 6), the Z-statistics of the pre-test and post-test data on PSTs' motivation towards AI were 0.149 and 0.174, respectively, and the p-values were 0.067 and 0.015, respectively. As the post-test data of the control group were not distributed normally ($p < 0.05$),

the Wilcoxon signed-rank test was used to compare and analyze PSTs' motivation towards AI in the control group before and after the intervention. The results showed that there was no significant difference between the total scores of the pre-test and post-test data on PSTs' motivation towards AI in the control group (P = 0.731 > 0.05), inferring that PSTs' motivation towards AI did not improve significantly after using the educational practice training module. Further analysis of the three dimensions of motivation towards AI found that there were no significant differences in PSTs' motivation (P = 0.122 > 0.05) and intrinsic motivation (P = 0.836 > 0.05) between the pre-test and post-test data. However, there was a significant difference in the extrinsic motivation (P = 0.000 < 0.05). The median of the pre-test and post-test data, and the difference between these two medians in the dimension of extrinsic motivation were evaluated. The results indicated that the median of the post-test data (Mdn = 3.92) was statistically significantly higher than that of the pre-test data (Mdn = 3.83). The median difference value of 0.17 indicated that the median increase in PSTs' motivation towards AI after the intervention was 0.17. Thus, PSTs in the control group significantly improved their extrinsic motivation after using the educational practice training module. However, the three aspects of motivation, internal motivation towards AI, and total score were not significantly improved. According to the findings, there was no significant difference in PSTs' motivation towards AI between the pre-test and post-test data in the control group. Thus, $H_{2b}$ was supported.

**Table 7.** Results of Wilcoxon signed-rank test for motivation between the pre-test and post-test in the control group

| | Posttest-pretest | Negative Ranks | | | Positive Ranks | | | Test Statistics | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Motivation | N | Mean Rank | Sum of Ranks | N | Mean Rank | Sum of Ranks | Ties | *Z* | *p* |
| 1 | AM | 18 | 14.94 | 269.00 | 10 | 13.70 | 137.00 | 4 | -1.546 | .122 |
| 2 | IM | 14 | 14.11 | 197.50 | 13 | 13.88 | 180.50 | 5 | -.207 | .122 |
| 3 | EM | 3 | 8.00 | 24.00 | 22 | 13.68 | 301.00 | 7 | -3.836 | .836 |
| | Total | 12 | 13.50 | 162.00 | 14 | 13.50 | 189.00 | 6 | -.344 | .000 |

Note: Amotivation= AM; Intrinsic motivation = IM; Extrinsic motivation = EM.

According to the one-sample K-S test, the Z-statistics of the pre-test and post-test data on PSTs' motivation towards AI were 0.088 and 0.180, respectively, and the p-values were 0.200 and 0.008, respectively. As the data was not distributed normally (p < 0.05), the Wilcoxon signed-rank test was used to compare and analyze PSTs' motivation towards AI in the experimental group before and after the intervention (Table 7). The results revealed that there was a significant difference between the total scores of the pre-test and post-test data on PSTs' motivation towards AI in the experimental group (P = 0.000 < 0.05). Further analysis of the three dimensions of motivation towards AI found that there were no significant differences in PSTs' amotivation (P = 0.095 > 0.05) and extrinsic motivation (P = 0.711 > 0.05) between the pre-test and post-test data. However, there was a significant difference in the dimension of intrinsic motivation (P = 0.000 < 0.05). Further median analysis showed that the median of the post-test data (Mdn = 3.69) was statistically significantly higher than the median of the pre-test data (Mdn = 3.54). The median difference value of 0.15 indicated that the median increase in PSTs' motivation towards AI after the intervention was 0.15. In terms of intrinsic motivation, the results revealed that the median of the post-test data (Mdn = 4.40) was statistically significantly higher than the median of the pre-test data (Mdn = 4.00). The median difference value of 0.60 indicated that the median increase in PSTs' intrinsic motivation after the intervention was 0.60. Therefore, PSTs in the experimental group significantly improved their motivation and intrinsic motivation towards AI after using SLBM-TAIS, but the two dimensions of amotivation and extrinsic motivation were not significantly improved. Thus, $H_{2c}$ was rejected.

**Table 8.** Results of Wilcoxon signed-rank test for motivation between the pre-test and post-test in the experimental group

| | Posttest-pretest Motivation | Negative Ranks | | | Positive Ranks | | | Test Statistics | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | N | Mean Rank | Sum of Ranks | N | Mean Rank | Sum of Ranks | Ties | Z | P |
| 1 | AM | 17 | 14.97 | 254.50 | 10 | 12.35 | 123.50 | 6 | -1.671 | .095 |
| 2 | IM | 3 | 7.83 | 23.50 | 26 | 15.83 | 411.50 | 4 | -4.218 | .000 |
| 3 | EM | 16 | 11.69 | 187.00 | 12 | 18.25 | 219.00 | 5 | -.370 | .711 |
| | Total | 5 | 15.70 | 78.50 | 27 | 449.50 | 449.50 | 1 | -3.491 | .000 |

Note: Amotivation= AM; Intrinsic motivation = IM; Extrinsic motivation = EM.

The results revealed that the difference in the total scores of motivation towards AI between the experimental and control groups was significant ($p < 0.05$) after the intervention. Moreover, the experimental group's median was statistically significantly higher than the median of the control group ($Mdn_{EG} = 3.69 > Mdn_{CG} = 3.61$), indicating that SLBM-TAIS could improve PSTs' motivation towards AI more than the educational practice training module. Further analysis of the three dimensions of motivation towards AI showed that there was no significant difference in amotivation between the experimental group and the control group ($P = 0.144 > 0.05$), thus showing that there was no difference between SLBM-TAIS and the educational practice training module on the influence of PSTs' amotivation. In addition, there were significant differences between the experimental group and the control group on the two dimensions of intrinsic motivation ($p = 0.000 < 0.05$) and extrinsic motivation ($p = 0.000 < 0.05$) after the intervention. It is worth noting that the median in the experimental group was higher than that of the control group in the dimension of intrinsic motivation ($Mdn_{EG} = 4.40 > Mdn_{CG} = 4.00$). This proved that SLBM-TAIS was better than the educational practice-training module in improving PSTs' intrinsic motivation. However, in the extrinsic motivation dimension, the median of the experimental group was lower than that of the control group ($Mdn_{EG} = 3.67 < Mdn_{CG} = 3.92$), inferring that SLBM-TAIS was not as effective as the educational practice training module in improving PSTs' extrinsic motivation. Based on the analysis results, SLBM-TAIS was better than the educational practice training module in improving PSTs' motivation and intrinsic motivation towards AI, but poorer in improving PSTs' extrinsic motivation. According to the findings, there was a significant difference in PSTs' motivation towards AI between the experimental and control groups in the post-test data. Thus, $H_{2d}$ was rejected.

**Table 9.** Mann-Whitney U-test results of the differences between the experimental group and control group on motivation after the intervention

| | | Median | | U | Z | p |
|---|---|---|---|---|---|---|
| | Motivation | EG | CG | | | |
| 1 | AM | 2.50 | 2.00 | 421.5 | -1.462 | .144 |
| 2 | IM | 4.40 | 4.00 | 226.5 | -4.021 | .000 |
| 3 | EM | 3.67 | 3.92 | 253.5 | -3.677 | .000 |
| | Total | 3.69 | 3.61 | 353.5 | -2.317 | .020 |

Note: Experimental group= EG; Control group= CG; Amotivation= AM; Intrinsic motivation = IM; Extrinsic motivation = EM.

After conducting the one-sample K-S test, the Z-statistics of primary school students' attitude in the experimental and control groups were both 0.144, and the p-values were 0.028 and 0.020, respectively. As the data did not distribute normally ($p < 0.05$), the Mann-Whitney U test was used to compare and analyze the two groups before the intervention (Table 9). The results revealed that the p-values of the six dimensions and the total scores of primary school students' attitude in the two groups before the intervention were greater than 0.05. These results showed that there was no significant

difference in primary school students' attitude between the experimental and control groups before the intervention. Thus, $H_{3a}$ was supported.

**Table 10.** Mann-Whitney U-test results of the differences between the experimental group and control group on primary school students' attitude before intervention

| | | Median | | U | Z | P |
|---|---|---|---|---|---|---|
| | Attitude | EG | CG | | | |
| 1 | ACA | 4.00 | 3.75 | 737.5 | -1.775 | .076 |
| 2 | Interest in AI | 4.33 | 4.17 | 786.0 | -1.358 | .175 |
| 3 | TTA | 1.50 | 1.50 | 833.0 | -.977 | .329 |
| 4 | AFB | 2.67 | 2.33 | 898.0 | -.403 | .687 |
| 5 | CA | 4.00 | 4.00 | 895.0 | -.428 | .668 |
| 6 | AD | 2.00 | 2.00 | 926.0 | -.163 | .871 |
| | Total | 3.12 | 3.04 | 815.0 | -1.106 | .269 |

**Note.** AI career aspirations= ACA; Interest in AI = IA; Tediousness towards AI= TTA; AI is for both, Boys and Girls= AFB; Consequences of AI= CA; AI is Difficult=AD.

After conducting the one-sample K-S test, the Z-statistics of the pre-test and post-test data on primary school students' attitude were 0.144 and 0.101, respectively, and the p-values were 0.020 and 0.200, respectively. As the data of the control group were not normally distributed since the p-value of the pre-test data was less than 0.05 ($p < 0.05$), the Wilcoxon signed-rank test was used to compare and analyze primary school students' attitude in the control group before and after the intervention (Table 10). Findings showed that there was no significant difference between the total scores of the pre-test and post-test data on primary school students' attitude in the control group (($P = 0.896 > 0.05$), inferring that primary school students' attitude in the control group were not improved significantly after using the educational practice training module. Further analysis of the six dimensions of primary school students' attitude found that five dimensions of attitude were not significant. Furthermore, the median of the pre-test and post-test data, and the difference between the two medians in the dimension of interest were evaluated. The results indicated that the median of the post-test data (Mdn = 4.33) was statistically significantly higher than that of the pre-test data (Mdn = 4.17). The median difference value of 0.17 indicated that the median increase in primary school students' interest after the intervention was 0.17. Based on the above data analysis results, primary school students in the control group significantly improved their interest after using the educational practice training module, but the total scores and the dimensions of career, tediousness, AI is for both (Boys and Girls), consequences, and difficulty were not significantly improved. The results showed no significant difference in PSTs' motivation towards AI between the pre-test and post-test data in the control group. Thus, $H_{3b}$ was supported.

**Table 11.** Results of Wilcoxon signed-rank test for primary school students' attitude between the pre-test and post-test in the control group

| Postest-pretest | | Negative Ranks | | | Positive Ranks | | | Test Statistics | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | N | Mean Rank | Sum of Ranks | N | Mean Rank | Sum of Ranks | Ties | Z | p |
| | Attitude | | | | | | | | | |
| 1 | ACA | 15 | 22.50 | 337.5 | 25 | 19.3 | 482.5 | 5 | -1.021 | .307 |
| 2 | IA | 9 | 13.89 | 125.0 | 26 | 19.42 | 505.0 | 10 | -3.145 | .002 |
| 3 | TTA | 18 | 19.39 | 349.0 | 16 | 15.38 | 246.0 | 11 | -.900 | .368 |
| 4 | AFB | 22 | 24.91 | 548.0 | 19 | 16.47 | 313.0 | 4 | -1.559 | .119 |
| 5 | CA | 23 | 18.57 | 427.0 | 15 | 20.93 | 314.0 | 7 | -.838 | .402 |
| 6 | AD | 23 | 23.74 | 546.0 | 18 | 17.5 | 315.0 | 4 | -1.533 | .125 |
| | Total | 19 | 19.03 | 361.5 | 19 | 19.97 | 379.5 | 7 | -.131 | .896 |

Note. AI career aspirations= ACA; Interest in AI = IA; Tediousness towards AI= TTA; AI is for both, Boys and Girls= AFB; Consequences of AI= CA; AI is Difficult=AD.

After conducting the one-sample K-S test, the Z-statistics of the pre-test and post-test data on primary school students' attitude were 0.144 and 0.117, respectively, and the p-values were 0.028 and 0.168, respectively. As the pre-test data of the experimental group did not distribute normally ($p < 0.05$), the Wilcoxon signed-rank test was used to compare and analyze primary school students' attitude in the experimental group before and after the intervention. Findings showed that there was a significant difference between the total scores of the pre-test and post-test data on primary school students' attitude in the experimental group ($P = 0.020 < 0.05$). Further analysis of the six dimensions of primary school students' attitude found that there were no significant differences in the tediousness ($P = 0.083 > 0.05$) and consequences ($P = 0.090 > 0.05$) between the pre-test and post-test data. However, there was a significant difference in the other four dimensions of attitude. Furthermore, the median of the pre-test and post-test data, as well as the difference between the two in the total score and the four dimensions of career aspirations, interest, AI is for both (Boys and Girls), and difficulty were examined. For the total score, the results indicated that the median of the post-test data (Mdn = 3.32) was statistically significantly higher than the median of the pre-test data (Mdn = 3.12). The median difference value of 0.12 indicated that the median increase in primary school students' attitude after the intervention was 0.12. In terms of career aspirations, the results revealed that the median of the post-test data (Mdn = 4.50) was statistically significantly higher than the median of the pre-test data (Mdn = 4.00). The median difference value of 0.50 indicated that the median increase in primary school students' career aspirations after the intervention was 0.50. In terms of interest in AI, the results suggested that the median of the post-test data (Mdn = 4.58) was statistically significantly higher than the median of the pre-test data (Mdn = 4.33). The median difference value of 0.33 indicated that the median increase in primary school students' interest in AI after the intervention was 0.33.

For the dimension of AI for both (Boys and Girls), the results suggested that the median of the post-test data (Mdn = 2.00) was statistically significantly higher than the median of the pre-test data (Mdn = 2.67). The median difference value of -0.67 indicated that the median decrease in the gender difference towards AI after the intervention was 0.67. Finally, for the dimension of AI is difficult, the results suggested that the median of the post-test data (Mdn = 1.75) was statistically significantly higher than the median of the pre-test data (Mdn = 2.00). The median difference value of -0.25 indicated that the median decrease in the dimension of AI is difficult after the intervention was 0.25. Based on the above analysis, SLBM-TAIS significantly impacted primary school students' attitude towards AI, mainly in four dimensions: career aspirations, interest, AI is for both (Boys and Girls), and difficulty. Career aspirations and interests of primary school students in the experimental group were significantly improved after the intervention, while gender differences towards AI and AI difficulty were significantly reduced. The results showed significant differences in primary school students' attitude between the pre-test and post-test data in the experimental group. Thus, $H_{3c}$ was rejected.

**Table 12.** Results of Wilcoxon signed-rank test for primary school students' attitude between the pre-test and post-test in the experimental group

| Posttest-pretest | | Negative Ranks | | | Positive Ranks | | | Test Statistics | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Attitude | N | Mean Rank | Sum of Ranks | N | Mean Rank | Sum of Ranks | Ties | Z | p |
| 1 | ACA | 6 | 8.50 | 51.00 | 33 | 22.09 | 729.00 | 3 | -4.781 | .000 |
| 2 | IA | 7 | 8.00 | 56.00 | 30 | 21.57 | 647.00 | 5 | -4.487 | .000 |
| 3 | TTA | 13 | 17.23 | 224.00 | 23 | 19.22 | 442.00 | 6 | -1.735 | .083 |
| 4 | AFB | 25 | 20.12 | 503.00 | 10 | 12.70 | 127.00 | 7 | -3.100 | .002 |
| 5 | CA | 15 | 14.17 | 212.50 | 20 | 20.88 | 417.50 | 7 | -1.695 | .090 |
| 6 | AD | 22 | 19.02 | 418.50 | 12 | 14.71 | 176.50 | 8 | -2.089 | .037 |
| | Total | 14 | 16.89 | 236.50 | 26 | 22.44 | 583.50 | 2 | -2.335 | .020 |

Note. AI career aspirations= ACA; Interest in AI = IA; Tediousness towards AI= TTA; AI is for both, Boys and Girls= AFB; Consequences of AI= CA; AI is Difficulty=AD.

Due to the absence of ANCOVA's assumptions, the non-parametric Mann-Whitney U test was used to compare the differences in primary school students' attitude between the experimental and

control groups (Table 12). Findings revealed that the difference in the total scores of primary school students' attitude between the experimental and control groups was significant ($p < 0.01$) after the intervention. Moreover, the experimental group's median was statistically significantly higher than the median of the control group ($Mdn_{EG}$ =3.32 > $Mdn_{CG}$ =3.08), indicating that SLBM-TAIS could improve primary school students' attitude towards AI more than the educational practice training module. Further analysis of the six dimensions of primary school students' attitude showed that there was no significant difference in tediousness (P = 0.159 > 0.05) and difficulty (P = 0.193 > 0.05) between the experimental group and the control group, indicating that there was no significant difference between SLBM-TAIS and the educational practice training module on the influence of primary school students' tediousness and difficulty towards AI.

In addition, this study also found that there were significant differences between the experimental group and the control group on the four dimensions of career aspirations (p = 0.000 < 0.05), interest (p = 0.000 < 0.05), AI is for both (Boys and Girls) (p = 0.016 < 0.05), and consequences (p = 0.004 < 0.05). Furthermore, the median of primary school students' attitude in the experimental group were higher than that in the control group in the three dimensions of career aspirations ($Mdn_{EG}$ = 4.50 > $Mdn_{CG}$ = 3.75), interest ($Mdn_{EG}$ = 4.58 > $Mdn_{CG}$ = 4.33), and consequences ($Mdn_{EG}$ = 4.25 > $Mdn_{CG}$ = 4.00), suggesting that SLBM-TAIS was better than the educational practice training module in improving the three dimensions of primary school students. As for the dimension of AI is for both (Boys and Girls), the experimental group scored lower than the control group ($Mdn_{EG}$ = 2.00 < $Mdn_{CG}$ = 2.33), suggesting that SLBM-TAIS was better than the educational practice training module in reducing gender differences for primary school students learning AI. Based on the above analysis, SLBM-TAIS was better than the educational practice training module in improving primary school students' attitude, career aspirations, interest in AI, and the consequences of AI. SLBM-TAIS was also better in reducing gender differences in learning AI. The results showed a significant difference in primary school students' attitude between the experimental and control groups in the post-test data. Thus, $H_{3d}$ was rejected.

**Table 13.** Mann-Whitney U-test results of the differences between the experimental and control groups on primary school students' attitude after the intervention

| | | Median | | U | Z | p |
|---|---|---|---|---|---|---|
| | Attitude | EG | CG | | | |
| 1 | ACA | 4.50 | 3.75 | 257.5 | -5.912 | .000 |
| 2 | IA | 4.58 | 4.33 | 414.5 | -4.587 | .000 |
| 3 | TTA | 1.75 | 1.50 | 784.5 | -1.408 | .159 |
| 4 | AFB | 2.00 | 2.33 | 668.0 | -2.401 | .016 |
| 5 | CA | 4.25 | 4.00 | 613.0 | -2.863 | .004 |
| 6 | AD | 1.75 | 1.75 | 794.5 | -1.302 | .193 |
| | Total | 3.32 | 3.08 | 391.5 | -4.712 | .000 |

Note**.** AI career aspirations= ACA; Interest in AI = IA; Tediousness towards AI= TTA; AI is for both, Boys and Girls= AFB; Consequences of AI= CA; AI is Difficult=AD.**;** Control group=CG; Experimental group= EG

## 5. Discussion and Implications

Based on the results, compared with the educational practice training module, SLBM-TAIS exhibited some effects on PSTs' practical knowledge and motivation towards AI, as well as primary school students' attitude towards AI. This study found that PSTs' practical knowledge and its six dimensions significantly improved after using SLBM-TAIS (Pereira & Costa, 2019). Consistent with previous studies, SLBM-TAIS was able to meet the conditions and needs of PSTs' practical knowledge better than the traditional educational practice training (Yanchar, 2016). Service-learning theory as the basis of SLBM-TAIS development emphasizes the importance of community practice in knowledge

acquisition and professional growth of PSTs, thus enabling them to integrate academic knowledge with real-life problems and practical experiences through reflections in practice and in action (Meidl, 2018).

Moreover, PSTs' motivation and intrinsic motivation towards AI were significantly improved after using SLBM-TAIS. The principles of understanding the meaning of learning, real-life examples, and hands-on activities explains why SLBM-TAIS improves PSTs' motivation (Qian & Lehman, 2018). The findings of this study are consistent with Law et al. (2019) which suggests that teachers' understanding of the meaning and purpose of learning can enhance their motivation. Previous research has shown that motivational power comes from PSTs' understanding and grasp of their learning goals, significance, and capabilities (Yong, 2017). SLBM-TAIS showed a significant effect on improving PSTs' internal motivation, possibly because PSTs find the meaning of learning and practice in SLBM-TAIS. SLBM-TAIS was also better than the educational practice training module in improving PSTs' motivation and intrinsic motivation towards AI. However, SLBM-TAIS did not perform better than the educational practice training module in improving PSTs' extrinsic motivation. The could be because service-learning, the theoretical basis of SLBM-TAIS, benefits PSTs and meets the real needs of the community, which greatly promotes the sense of achievement and stimulates their motivation (Binsaleh & Binsaleh, 2021). This research result is consistent with Zhizhong and Subin (2020) who believed that the traditional educational practice training module has a significant effect in improving external motivation, but has little effect on internal motivation.

This study also found that SLBM-TAIS exhibited a positive impact on the attitude of primary school students taught by PSTs towards AI, mainly in the four dimensions of career aspirations, interest, AI is for both (Boys and Girls), and difficulty. Career aspirations and interests of primary school students in the experimental group were significantly improved after the intervention. At the same time, gender differences towards AI as well as AI difficulty were significantly reduced. One possible reason for explaining the positive effect on attitude towards AI is that in SLBM-TAIS, PSTs are fully prepared in the activity preparation and instructional design. This study also investigated students' attitude towards gender differences. The results of the study showed that both boys and girls believed that the gender difference was not significant after the intervention of SLBM-TAIS. The could be due to the design of SLBM-TAIS which attaches great importance to integrating real-life examples into the course content, encouraging cooperative learning and the creation of works. Similar effects are observed in the work of Ardies et al. (2012) which identified that teachers' knowledge preparation affects teaching and students' attitude towards technology. This finding is consistent with the research of Yu et al. (2012) which suggests that PSTs should devote themselves to developing teaching materials and activities to stimulate students' attitude. Classroom activities closely related to hands-on activities and real-life examples positively impact primary school students' attitude towards AI. When students learn through a variety of hands-on activities in the classroom, they are able to understand the relationship between technology and life, and flexibly integrate technology to real-life applications. As a result, their attitude towards technology will be improved (Fook et al., 2021; Lim et al., 2020).

Therefore, the results of this study may help researchers, college teachers, and administrators to understand the best way to promote PSTs' practical knowledge and motivation, as well as primary school students' attitude towards AI. The results of this study proves that promoting students' development is a new value orientation of the service-learning theory in the field of teachers' education. Although SLBM-TAIS is not directly related to the students, it can change the psychology and behavior of PSTs to further affect the learning psychology of students, ultimately promoting the development of students. This research not only follows the important principle of service-learning with regard to both PSTs and students as important beneficiaries, but also takes new value orientation into account. Therefore, this research provides a certain valuable reference for the localization of the service-learning theory and its integration with PSTs' education theory.

As far as the practical implication is concerned, this research has developed SLBM-TAIS to train PSTs to teach primary school students AI subjects. Results of this study can be used in the teacher training module, especially in improving practical knowledge and motivation. At the same time, the research results may also be beneficial for the development of AI-related projects or courses at the primary school level, and may provide useful and valuable information to improve primary school students' attitude towards AI. The results of this study may be extended to other training modules that train teachers in educating AI to primary school students. In addition, the research provides university teachers with practical suggestions on how to train PSTs in educating AI to primary school students,

and provides practical advice to solve the teachers' problems of limited practical knowledge acquisition and lack of motivation. The results of this study have not only proven that SLBM-TAIS can enhance PSTs' practical knowledge and motivation, but they have also identified the influencing factors through literature review. These influencing factors are very helpful for university teachers to select appropriate teaching principles, contents, processes, tools, and methods in their training model development and implementation. These key elements identified in SLBM-TAIS can provide practical implications for university teachers who want to develop training models.

This study concludes that SLBM-TAIS is an effective method to train PSTs to teach AI subjects to primary school students. SLBM-TAIS improves PSTs' practical knowledge and motivation, and primary school students' attitude towards AI. In addition, SLBM-TAIS is better than the educational practice training method in improving practical knowledge, motivation, and attitude towards AI. Although the educational practice training module can significantly improve practical knowledge, it has no significant effect in improving motivation and attitude. Moreover, SLBM-TAIS provides a solution to solve the problems or dilemmas faced by the traditional teacher training module. The SLBM-TAIS developed in this research provides a new method for the training of PSTs and primary school students, which can promote PSTs' practical knowledge and motivation, as well as primary school students' attitude towards AI.

## 7. Recommendations for Future Research

Future research can focus on the next stage of AI education. Researchers can also examine the effects of SLBM-TAIS on the three psychological variables at other levels of education, not just for PSTs and sixth-grade students. Additionally, future research can use qualitative research methods to explore how SLBM-TAIS affects PSTs' practical knowledge and motivation, primary school students' attitude, and subsequently, to explore how to influence students' learning psychology by changing the practice and behavior of PSTs.

## 8. Limitation and Direction to Future Studies

Self-reporting has well-known limitations, which the researchers of the present study have considered. Furthermore, as PSTs and students in the intervened group had prior knowledge of the intervention, their answers in the questionnaires contained 'positive bias' elements. This was evident where the students who participated in this study had prior expectations that the intervention would yield positive outcomes. Taking this into consideration, exaggeration by the intervened group was expected in the results. Finally, the relatively small sample size limited the external validity of this study. Future research may consider a larger sample size of PSTs and students. Longitudinal designed studies, with a minimum of three evaluation waves, may be employed to gauge the role of SLBM-TAIS.

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