Asian Journal of Education and Social Studies

29(4): 20-25, 2022; Article no.AJESS.88227
ISSN: 2581-6268

Assessment of the Instructional Design Ability of Pre-service Mathematics Teachers in China

Liyan Yin [a] and Zezhong Yang [a*]

[a] School of Mathematics and Statistics, Shandong Normal University, Jinan, China.

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJESS/2022/v29i430706

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/88227

Review Article

Received 27 March 2022
Accepted 09 June 2022
Published 13 June 2022

ABSTRACT

The universities can obtain important references to improve the professional ability efficiently of undergraduates majoring in mathematics education by assessing the instructional design ability of pre-service mathematics teachers. However, there is a paucity of literature on the assessment of the instructional design ability of pre-service mathematics teachers in China. In this study, theoretical analysis is used as a research method, and providing an referenced assessment method on the instructional design ability of Chinese pre-service mathematics teachers is the main purpose. Through analyzing the relevant definition and theories, we found that the speed and quality of completing instructional design can be deemed as the core of assessing the instructional design ability, and the critical point of assessing the quality of instructional design is whether instructional design can achieve the teaching objectives or not. Based on the above analysis results, we proposed an assessment method including the examination way of the instructional design ability of pre-service mathematics teachers in China, examination questions, scoring raters, and scoring criteria. This study can provide a reference for further in-depth studies of the instructional design ability of pre-service mathematics teachers in China.

Keywords: Pre-service Mathematics Teacher; instructional design ability; assessment.

**Corresponding author: Email: zhongzee@163.com;*

1. INTRODUCTION

The instructional design ability of pre-service mathematics teachers will impact their teaching level and reflect the professional level of universities in China [1-2]. Therefore, the assessment of the instructional design ability of pre-service mathematics teachers can not only meet the needs of improving education quality for universities in China but also provide a reference for pre-service mathematics teachers to know their ability [1]. However, the current problem is that there is a paucity of literature on the assessment of the instructional design ability of pre-service mathematics teachers in China. Therefore, this paper intends to research how to assess the instructional design ability of pre-service mathematics teachers in China and provide a referenced assessment way. We hope to provide a reference for further in-depth studies on how to effectively assess the instructional design ability of pre-service mathematics teachers in China.

2. THEORETICAL BASIS

2.1 Pre-service Mathematics Teachers

Some scholars defined pre-service teachers as college students who will soon be teachers after graduation [3]. On this basis, Some scholars define the pre-service mathematics teacher as college students majoring in mathematics education [4], while others define them as the senior students majoring in mathematics and applied mathematics [5]. Through referring to the above definition and the definition in other disciplines [6-7], we define pre-service mathematics teachers as college students who have professional mathematics knowledge, are about to experience or have experienced practice, and will be mathematics teachers within 1 to 3 years after graduation.

2.2 Instructional Design

At present, scholars have different definitions of instructional design. They focus on two views with the definition of instructional design. One is that instructional design is deemed as a process of solving problems in teaching and learning. For example, Pi thought instructional design is the process of analyzing the teaching problems, designing the solution, implementing and evaluating the scheme, and further optimizing the scheme. This process is based on teaching theory, learning theory, communication studies, and psychology [8]. The other view is that instructional design is deemed as a process of planning teaching. For example, Wu believes that aim of instructional design is to optimize the teaching effect. This is a process of setting teaching objectives, analyzing teaching problems and formulating a program, evaluating and modifying the program [9]. Because the second view is easier to implement, it has been recognized by many scholars in China.

This paper adopted the second view and defines the instructional design as follows: Instructional design is the activity of designing a reasonable teaching program to achieve the teaching objectives, which are based on the teaching theme, the students' characteristics, and the instructional theories.

2.3 Ability

Ability is defined slightly differently in each field. In the workplace, some scholars call ability *Competence,* which is regarded as the characteristic of completing a job [10]. In psychology, many scholars define ability as the psychological characteristics affecting activity efficiency in activities [10-12]. The definition of ability in psychology has been used by many scholars in China. This paper adopts the definition of ability in the field of psychology.

2.4 Instructional Design Ability

Instructional design ability is a special ability shown in instructional design [13]. However, there is no unified definition of instructional design ability at present. In this paper, according to the above definition of *Instructional Design* and *Ability*, we define the instructional design ability as follows: Instructional design ability is the ability to achieve teaching objectives by designing reasonable instructional programs, which based on professional knowledge and teaching skills, refers to the content theme and student characteristics, and using the theories of teaching and learning.

3. ASSESSMENT OF INSTRUCTIONAL DESIGN ABILITY

3.1 Assessment Basis

The instructional design ability is a special ability shown in the instructional design activities. We

can consider first how to assess the ability, and then consider how to assess the instructional design ability, finally providing a referenced assessment protocol on the instructional design ability of Chinese pre-service mathematics teachers.

3.1.1 How to assess ability

According to the above definition of ability, it can be seen that the ability is expressed as a person's efficiency in the activities. In other words, more competent people are more efficient. As we know, the two indicators of efficiency are speed and quality of activities. Therefore, the speed and quality of work can be used to assess ability.

3.1.2 How to assess the instructional design ability

Based on the assessment indicators of ability, the assessment of the instructional design ability should pay attention to the speed and quality of completing the instructional design. Based on previous experience, we know that times could measure speed. Based on the above definition, achieving the teaching objectives is the main purpose of the instructional design. Therefore, the critical point of assessing the quality of instructional design is whether instructional design can achieve the teaching objectives or not.

3.2 Examination Ways of the Instructional Design Ability

Based on the above analysis, it is feasible that let pre-service mathematics teachers complete some examination questions related to the teaching design, and evaluate their teaching design ability by observing the time of completing the questions or assessing the quality of the instructional design. Therefore, there are two ways to assess the instructional design ability of the pre-service mathematics teachers in China.

The first way is that the pre-service mathematics teachers are required is to complete the instructional design questions based on content themes, learning situations of students, and teaching objectives. The requirement is that instructional design must be able to achieve teaching objectives. If the pre-service mathematics teachers spend less time completing it and achieving requirements, the better the instructional design ability is.

The second way is that pre-service mathematics teachers need to complete the instructional design in a limited time based on content themes, the learning situation of students, and teaching objectives. The main purpose focus on observing the quality of the instructional design. If this instructional design can achieve teaching objectives, which represents the good quality of the instructional design and means that the instructional design ability of the pre-service mathematics teacher is strong.

However, the location and spare time of pre-service mathematics teachers are so scattered that researchers record the time and receiving the answers is very difficult. Therefore, the second way is more convenient and the best choice to examine the instructional design ability of the pre-service mathematics teachers in China.

3.3 Examination Questions

3.3.1 The basis requirement of examination questions

According to the definition of instructional design ability, the content theme and learner situation are the basis of completing the instructional design, achieving teaching objectives is the ultimate goal of instructional design. Therefore, content themes, learner situations, and teaching objectives should be set in the examination questions.

Firstly, the content theme of instructional design should include textbooks and chapters. For example, the content theme is *Explore the Pythagorean theorem* [14], which was selected from a mathematics textbook published by Beijing Normal University Press. Secondly, the characteristics of students should include the mathematics achievement in a class and other basic information. The mathematics achievement of a class can be expressed as follows: students with excellent math scores account for 50%, students with ordinary math scores account for 40%, and students with poor math grades account for 10%. Thirdly, the teaching objectives should be specific and operational. For example, the teaching objective is that students can understand the proof method of the *Pythagorean Theorem*, master the theorem, and use the

theorem to solve related mathematical problems and practical problems.

3.3.2 The questions

According to the second examination way of the instructional design ability, two examination questions related to the instructional design can be compiled to examine the instructional design ability. The one is about junior high school content, the other about senior high school content. The full score of the test paper is one hundred points, each question accounts for fifty points, and the test time is sixty minutes. The examination questions include two kinds of math learning situations, two content themes, and different teaching objectives.

(a) Question 1

Question 1 is about geometry in the mathematics textbook of the junior middle school in China, and the math performance of the students is good. Question 1 is as follows: Please refer to the students' mathematics achievement, teaching objectives, and content theme about *Exploration of the Pythagorean Theorem* [14] to complete an instructional design. This part is selected from the junior middle school mathematics textbook in China published by *Beijing Normal University Press*. Teaching objectives are that students understand the proof method of the *Pythagorean Theorem*, master the *Pythagorean Theorem*, and use the theorem to solve related mathematical problems and practical problems. Besides, students with excellent math scores account for 50%, students with middle math scores account for 40%, and students with poor math grades account for 10%. Note: the teaching process is written in as much detail as possible.

(b) The Question 2

Question 2 is about geometry in the high school mathematics textbook in China, and the math performance of students is ordinary. Question 2 is as follows:

Please refer to the students' mathematics achievement, teaching objectives, and content theme about *Summation of Arithmetic Sequences* [15] to complete an instructional design. The content is selected from the junior middle school mathematics textbook published by *People's Education Press*. Teaching objectives are that students understand the properties of an arithmetic sequence, master the sum formula of an a*rithmetic sequence*, and apply the formula to solve practical problems. Besides, students with excellent math scores account for 20%, students with ordinary math scores account for 40%, and students with poor math scores account for 20%. Note: the teaching process is written in as much detail as possible.

3.3.3 Scoring criteria

Each question is fifty points and involves the three instructional objectives. fifty points can be assigned equally to three teaching objectives, and each objective will be scored separately.

When the instructional designs were assessed, different scores should be given according to the specific situation of their design. For example, the teaching objective is that understand the proof method of the *Pythagorean Theorem* in question 1. Raters will give a full score of 16 if students can understand the proof method of the *Pythagorean Theorem* through this instructional design; Raters will give zero points if the students can not understand the proof method of the *Pythagorean Theorem* through this instructional design; if the instructional design can achieve objectives but the process is not perfect or not specific, the score will be 40% - 70% of the total score, which is 6 to 12 points. Other parts are scored on similar criteria. Detailed scoring criteria are shown below in Table 1.

3.3.4 Scoring raters

To ensure the reliability of the scores, each question should be scored by multiple raters, and the average rating by the multiple raters is taken as the final score. In addition, to ensure the reliability of scores, raters should have strong instructional design ability and extensive teaching experience.

Therefore, mathematics teachers in middle school with more than ten teaching years and outstanding teaching ability to be invited to this evaluation as raters. Among them, three mathematics teachers in middle school as the raters of question 1, and then took the average as the final score of question 1. Three mathematics teachers in senior high school as the raters of question 2, and then took the average as the final scores of question 2. Finally, the scores of the two questions are summed up to get the total scores.

Table 1. Scoring criteria

Content Theme of Instructional Design	Teaching Objective	The Core Point of Scoring	Scoring Criteria
Question 1: *Exploring the Pythagorean Theorem* (50 Points)	Students can understand the proof method of the *Pythagorean Theorem* (16 points)	Whether can students understand the proof method of the *Pythagorean Theorem* or not?	(a) Students can understand the proof method (16 points); (b) Students can understand it but the design is not perfect or specific (6-12 points); (c)Students can not understand it (0 points)
	Students can master the *Pythagorean Theorem* (17 points)	Whether the students can master the *Pythagorean Theorem* or not?	(a) Students can master it (16 Points) (b) Students can master it but the design is not perfect or specific (6-12 points) (c) Students can not master it (0 points)
	Students can apply the *Pythagorean Theorem* to solve related mathematical problems and practical problems (17 points)	Whether the students can apply the *Pythagorean Theorem* to solve related mathematical problems and practical problems or not?	(a) Students can apply it to solve the problems (17 points) (b) Students can use it to solve the problems but the design is not perfect or specific (6-12 points). (c) Students can not apply it to solve related the problems (0 points)
Question 2: Summation of *Arithmetic Sequences* (50 Points)	Students understand the properties of the a*rithmetic sequence* (16 points)	Whether the students can understand the properties of the a*rithmetic sequence* or not?	(a) Students can understand it (16 Points) (b) Students can understand it but the design is not perfect or specific (6-12 points) (c)Students can not understand it (0 points)
	Students master the summation formula of the a*rithmetic sequence* (17 points)	Whether the student can master the summing formula of the a*rithmetic sequence*?	(a) Students can master it (16 Points) (b) Students can master it but the design is not perfect or specific (6-12 points) (c) Students can not master it (0 points)
	Students can solve practical problems with the summation formula of the a*rithmetic sequence* (17 points)	Whether students apply the summation formula of the a*rithmetic sequence* to solve practical problems or not?	(a) Students can apply it to solve the problems (17 points); (b) Students can apply it to solve the problems but the design is not perfect or specific (6-12 points); (c) Students can not apply it to solve the problems (0 points)

4. CONCLUSION

In this study, through analyzing the relevant definition and theories, we found that the speed and quality of completing instructional design can be deemed as the core of assessing the instructional design ability, and the critical point of assessing the quality of instructional design is whether instructional design can achieve the teaching objectives or not. Therefore, it is

reasonable to think that the assessment of the instructional design ability of pre-service mathematics teachers should be focused on whether instructional design can achieve teaching objectives or not. Based on the above results, we proposed an assessment method including the examination ways of the instructional design ability of pre-service mathematics teachers in China, examination questions, scoring raters, and scoring criteria. This assessment method is comprehensive and ensures good reliability and validity of assessment results.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Li T, Dai B. Study on the current situation of instructional design ability of mathematics normal university students. Education modernization. 2019;9(6):92-93.
2. Zuo K. Research on instructional design ability of mathematics teachers in Junior Middle School. Journal of Mathematics Education. 2011;19(2):41-44.
3. Zhang XJ. Research on pre-service teachers' learning ability and influencing factors about their school (Master's thesis, Northwest Normal University, Lanzhou); 2016. Available:https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD202201&filename=1021662447.nh
4. Liu FF. A comparative study of mathematics instructional design ability and development of pre-service teachers at different levels (Master's thesis, Liaoning Normal University, Dalian); 2016. Available:https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD201701&filename=1016244280.nh
5. He XY. Research on the development of mathematics instructional design ability of pre-service teachers (Master's thesis, East China Normal University, Shanghai); 2020. Available:https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD202002&filename=1020636546.nh
6. Zhao, Y. Research on the current situation of information teaching ability of a university in Wuhan as an example (Master's thesis, Central China Normal University, Wuhan); 2021. Available:https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CMFD202201&filename=1021149817.nh
7. Huo J. Research on the Construction of Experimental Teaching Ability (Doctoral Dissertation, Southwest University, Chongqing); 2021. Available:https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CDFDLAST2022&filename=1021768566.nh
8. Pi LS. Instructional design-The Theory and Technology of Psychology. Beijing: Higher Education Press; 2002.
9. Wu MN. Instructional Design. Beijing: Higher Education Press; 1994.
10. Li ZX. Ability Psychology. Xian: Shanxi People's Education Press; 1985.
11. Ye YQ. General Psychology. Shanghai: East China Normal University Press; 1997.
12. Yang ZZ. Mathematics Learning theory and method. Zittau: Weser Books; 2019.
13. Li Y, Yang K. Investigation on the instructional design Ability of Normal University Students of Independent University. Journal of Changchun Education Institute. 2019;35(6):59-61.
14. Zhang F, Wang YH. Compulsory education mathematics textbook (the first volume of grade eight). Beijing: Beijing Normal University Press; 2013.
15. Xue B, Song LL, Liu CM. Mathematics textbook of standard experimental curriculum in ordinary senior high school. Beijing: People's Education Press; 2004.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/88227