Enhancing Teacher Education Students' Diagnostic and Instructional Design Capabilities in a Teacher Education Course

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This study developed a teacher education program for teacher education students (TESs), incorporating collaborative inquiry and panoramic cameras to guide them in observing young students' learning performances during teaching, with the goals of enhancing instructional design capability for diagnosing student learning problems and investigating the feasibility of this approach. Twenty-two participants, divided into five groups, engaged in teaching practice across five different junior high school classes simultaneously. The remaining 17 participants conducted classroom observations. Post-teaching discussions of a group followed, with this three-week cycle repeating four times, allowing each TES to serve as a teaching educator. The study concludes that TESs' diagnostic abilities in identifying student learning problems have improved, along with a noticeable positive change in their perceived capabilities for designing teaching activities. Overall, the proposed course framework demonstrates feasibility in teacher education.

INTRODUCTION

Teacher education students (TESs) should be equipped with teaching competencies before obtaining their certificate of teaching. Currently, in Taiwan, teacher educators often integrate classroom observations and teaching practicum in primary and secondary schools into teacher education courses for TESs. A noteworthy phenomenon is that Taiwanese TESs, while conducting classroom observations, often concentrate on the teaching techniques employed by experienced teachers. Even during post-observation discussions with these experienced teachers, the TESs consistently tend to focus on learning the design of teaching strategies, with less emphasis on addressing the learning difficulties of young students in the comprehension of learning contents. This apprenticeship-style observation may lead TESs to misconstrue that the pedagogical approaches learned from observing in-service educators are generally effective (Thompson, 2006). Moreover, when TESs engage in teaching practice following the design of lesson plans, their emphasis tends to be more on executing the teaching processes outlined in the plans rather than actively seeking to comprehend the performances of young students during instruction. In other words, TESs may recognize the importance of mastering teaching techniques for becoming effective teachers, yet they might not fully understand that effective teaching crucially involves addressing the challenges faced by young students.

Carefully observing the learning challenges of young students during teaching activities, as suggested by Korthagen and Kessels (1999), can facilitate instructors in reflecting on their instructional designs and positively enhance pedagogical proficiency. Studies also emphasize the importance of shifting classroom observations towards perceiving young student performances and highlight the ability of instructors to perceive and diagnose learning problems for improving teaching quality and enhancing learning effectiveness (Deng et al., 2020; Thompson, 2006). Such a transition has the potential to facilitate TESs to reflect on their initial teaching philosophies, fostering the development of instructional design capability that corresponds to the learning needs of students. The purpose of this study was to assist TESs in developing instructional design capability based on the diagnosis of young student learning issues.

However, an emerging challenge is that TESs may lack the ability to diagnose learning problems in young students, as the findings of the previous studies (Boling, 2003; Foote et al., 2000), even when reminded to observe their behaviors. An additional challenge is that TESs with limited teaching experience encounter difficulties in systematically identifying student learning issues after engaging in teaching practices and reflecting on their initial teaching designs. Previous teacher education programs guide TESs in instructional design, typically addressing lesson topics and learning content, the aims of the lesson and instructional objectives, learning activities and methods, and assessment designs in relation to these objectives (Cameron & Campbell, 2013). Recognizing the limitations of the aforementioned model in enhancing the instructional design abilities of TESs, teacher education programs now provide opportunities for TESs to engage in practical teaching in educational settings. This approach helps TESs understand the reasons for using various teaching strategies (Sural, 2019) and build interrelationships between theory and practice (Contreras et al., 2020). Despite current teacher education programs incorporating practical teaching aspects to enhance the instructional design capabilities of TESs, a significant challenge remains in reflecting on their teaching practices. Due to the difficulty in diagnosing young students' learning problems, TESs still encounter challenges in reflecting on and improving their instructional design capabilities. Essentially, a reconsideration of teaching practice approaches in teacher education programs is needed.

This approach to collaborative inquiry is increasingly acknowledged as a crucial pathway for teachers' professional development (Nelson et al., 2008). Studies have demonstrated that collaborative inquiry benefited TESs in teaching professional development (Mule, 2006; Yang et al., 2022). In the context of classroom teaching, a group of teachers collaboratively identifies real learning problems and proposes corresponding teaching methods. During practical implementation, they collect and analyze evidence of student performance to evaluate the effectiveness of the proposed teach-

ing methods (Donohoo, 2013; Donohoo & Velasco, 2016). Cross et al. (2022) highlighted the benefits of incorporating panoramic cameras into teacher education and professional development, emphasizing their practicality in revealing the visual aspect of teaching practices. A teacher education program should not only guide TESs in implementing their teaching plans but also encourage collaboration among TESs to observe the learning performances of young students during instruction. Subsequently, following the teaching session, observers and instructors engage in collaborative discussions to identify any learning difficulties or issues faced by young students with the assistance of panoramic camera footage, exploring the connections between these learning difficulties challenges and the teaching activities. Furthermore, instructors may have the opportunity to adjust their original teaching plans based on the aforementioned discussions, ultimately enhancing their instructional design capabilities.

Accordingly, this study developed a teacher education course for TESs by integrating the collaborative inquiry concept and the use of panoramic cameras. The program guides TESs in observing the learning performances of young students in the classroom during teaching. Through diagnosing student performance and engaging in reflection, TESs could adjust their initial teaching plans. This study addressed two research questions:

1. **Whether this teacher education course could improve TESs' diagnostic capabilities regarding student learning difficulties?**
2. **Whether this teacher education course could enhance TESs' instructional design capabilities?**

LITERATURE REVIEW

Diagnosing Student Learning Problems and Designing Teaching Activities

An effective teacher should attentively observe student learning behaviors, diagnose student responses to teaching activities, develop creative solutions in response to difficulties, and ultimately comprehend the influence of the taught content on student learning outcomes (Darling-Hammond & Bransford, 2005). This proficiency in diagnosing student learning performance, which has become a key element of teachers' professional knowledge (Kukla-Acevedo, 2009), involves accurately assessing characteristics related to learning performance—a crucial teaching competency for teachers, especially within the context of complex teaching approaches and instructional decision-making (Artelt & Rausch, 2014; Deng et al., 2020). Through diagnosing student learning problems, teachers can develop corresponding teaching strategies, enhancing both student learning and the development of teachers' instructional design capability.

The diagnosis of student learning problems, revealing the effect of teaching activities on young students, can be observed and analyzed through their externally manifested behaviors, reflecting their internal cognitive processing of instructional material information (Deng et al., 2020). According to Gagné's Conditions of Learning theory (1985), effective instruction should involve diverse external stimuli that support students' cognitive processes. Instructional activity design, as stimuli tailored by teachers to align with students' cognitive processes, aim to lead students through a series of activities fostering learning comprehension. These activities encompass material presentation and narration, interactive discussions, exploration of complex information, and review activities involving information organization during and after the learning process. By documenting students' learning behaviors in each teaching activity as well as utilizing their responses as evidence, a classroom observer can deduce the effectiveness of the instructional activity organization in enhancing students' understanding. Furthermore, this approach aids in diagnosing learning challenges students face throughout the learning process.

Based on the aforementioned theoretical perspectives, the definition of diagnosing student learning problems entails teachers observing students' performances during the implementation of teaching activities designed for their cognitive processes and subsequently identifying potential reasons for the absence of established learning effectiveness.

Concretely, if instructors design teaching activities based on students' cognitive processes for specific learning content, classroom observers can observe and record students' performance in each specific activity. This approach facilitates an exploration of students' cognitive and information processing within instructional methods, especially in evaluating their comprehension of the material through worksheets, responses to teacher questions, or content discussed during peer interactions. When observers discern challenges in student learning during specific activities, they can offer the identified content to teachers for evaluating the feasibility of the existing instructional design. In accordance with Butler and Schnellert's (2012) recommendations, conducting observations specifically focused on students with learning difficulties proves conducive to fostering improvements in TESs' instructional design capabilities.

Studies have investigated the effects of the aforementioned classroom observation and post-teaching discussion on the development of pedagogical knowledge TESs. Sims and Walsh (2009) emphasized the necessity for TESs to redirect their observation focus from teachers to students, concentrating on the learning of instructional content. This shift involves understanding the complex relationship between teaching activities and students' comprehension of the learning material. Murata and Pothen (2011) as well as Myers (2012) contend that involving TESs in the investigation of challenges in student learning within the framework of lesson study, coupled with reflections on teaching activity design and subsequent adjustments through post-instruction discussions, offers opportunities for the enhancement of their pedagogical knowledge. However, Bjuland and Mosvold (2015) discovered that TESs lacked diagnostic observational skills; when asked about their observations, most mentioned observing students but struggled to provide specific details about student learning. In a study by Kramer et al. (2021), TESs trained in the use of diagnostic tools demonstrated effectiveness by analyzing data within specific contexts, often emphasizing students' learning challenges within the instructional content. From these studies, it is evident that TESs can be trained to observe and diagnose learning performances, enhancing their understanding of the correlation between student learning outcomes and the instructional activities they design and implement. The mentioned training benefits TESs in fostering the development of their pedagogical knowledge. However, further investigation is necessary to explore the diagnosis of student learning problems and its impact on the instructional design capabilities of TESs.

A Model Combines Collaborative Inquiry with the Use of Panoramic Cameras

Collaborative inquiry serves as a framework for identifying and solving problems, with its application in teaching aimed at improving student learning difficulties and developing appropriate pedagogical knowledge. To collect data on student learning performance, when a teacher conducts instruction, other teachers within the group engage in classroom observations and record-keeping. Following the teaching session, the teaching and observing educators conduct post-lesson discussions. Throughout the teaching process, observers are required to meticulously document and describe various aspects of students' performances. Following teaching practices, teachers are inclined to engage in reflective analysis, as noted by Ferguson and Sutphin (2019). This reflective process extends to post-lesson discussions, where observers, drawing from collaborative inquiry processes (Lewis & Hurd, 2011; Zepeda, 2012), share data and articulate perspectives, enhancing the overall exploration of teaching approaches. Donohoo (2013) further emphasizes that the teaching educators, in the aforementioned process, can adjust their original teaching plans and strategies through reflection. The collaborative reflection facilitated by peer assistance, as mentioned by Gómez et al. (2019), results in increased teaching inferences and expanded instructional knowledge. Observers highlight the relationship between teaching activities and student behavioral issues, making it easier for teaching educators to collectively perceive the impact of instructional activity design on student learning or identify deficiencies in teaching activities. This process fosters awareness of aspects for improvement in instructional activity design. Conversely, insufficient documentation or unclear explanations of student performance by observers impede the sharing of specific reflective viewpoints during post-lesson discussions, making it challenging to propose effective teaching strategies for improving student learning problems. Therefore, the processes of observation and post-teaching discussion play crucial roles in the practice of collaborative inquiry.

Coburn and Stein (2010), as well as Donohoo (2013), proposed a set of steps for collaborative inquiry, focusing on the connections between classroom teaching practices and student learning performances. These steps comprise: 1. framing the problem, 2. collecting evidence, 3. analyzing evidence, and 4. documenting, sharing, and celebrating. The initial two phases encompass lesson preparation, classroom teaching, and classroom observation, while the subsequent two stages are dedicated to post-lesson discussions, utilizing substantial evidence to demonstrate the efficacy of proposed interventions or adjust instructional plans to improve learning outcomes. Additionally, drawing upon the concept of teacher collaborative inquiry, Cranston (2019) introduced the 'Lab Class Model.' This model centers on student dialogue, action, and visible performance, dedicated to enhancing the quality of student learning throughout the teaching cycle. In summary, collaborative inquiry into student learning problems revolves around addressing frequently encountered learning issues. This process enables teachers to refine their ideas and practices in lesson preparation, teaching, observation, and subsequent post-lesson discussions and reflections.

Studies demonstrated the effectiveness and challenges associated with collaborative inquiry in teaching. Supovitz (2006) discovered that members of teacher professional communities, through collaborative inquiry into teaching practice issues, could develop a profound understanding of student learning problems. A study by DeLuca et al. (2017) also suggested that adopting the principles of collaborative inquiry to focus on teaching practice could direct educators' attention to students' learning performances, thereby enhancing student learning outcomes. However, the study by DeLuca et al. also highlighted that, despite educators generally acknowledging the value of collaborative inquiry, in practical implementation, observers encounter challenges in collecting sufficient evidence of student learning problems. Potentially, an innovative technology, such as panoramic cameras, could assist in addressing this challenge.

Figure 1 depicts the operational workflow of a panoramic camera. Initially, the camera establishes a connection with a mobile phone application. Subsequently, it is securely positioned on a tripod at the focal point of a designated student group. When the video recording approaches the predetermined time limit for a single session, a TES activates the record button on the cellphone app to continue the video recording. The recorded videos are then transferable to a computer for subsequent viewing (see Figure 1).

A specific software facilitates the conversion of the recorded video into a series of images with different angles (see Figure 2), providing observers with the capability to navigate through various viewing perspectives. Observers have the option to pause, play, and replay the video, modify the viewing angle, or zoom in to focus on specific students or their worksheets. The camera's audio recording capacity enables observers to hear the instructor and conversations within the student group, proving especially valuable during discussions on group projects.

Cross et al. (2022) highlighted the benefits of employing panoramic cameras in teacher education and professional development, emphasizing their positive influence on teaching improvement and recommending additional exploration of their practical implications for enhancing teacher learning. In collaborative inquiry into student learning problems, panoramic cameras (as shown in Figures 1 and 2) assist observers in reviewing, verifying, and supplementing post-observation records. This facilitates the maintenance of comprehensive evidence data for deducing student learning issues.

As teacher educators, examining the learning activities of TESs could enrich teacher education courses. The scholarship of teaching and learning in teacher education offers teacher educators a structured framework to systematically investigate questions regarding TESs' learning. When teacher educators identify learning issues among TESs, they can translate their philosophies into curriculum design after reviewing the literature. Subsequently, through implementation and further data collection, teacher educators can reflect on their initial philosophies and promote reform in teacher education programs. Based on the previously reviewed literature regarding collaborative inquiry (Coburn & Stein, 2010; Cranston, 2019; Cross et al., 2022; Donohoo, 2013), particularly on lesson preparation, classroom teaching, classroom observation, and post-teaching discussion, this study developed an integrated model of collaborative inquiry using panoramic cameras, focusing on TESs' ability to diagnose young students' issues and enhance their instructional design capabilities. The steps were as follows:

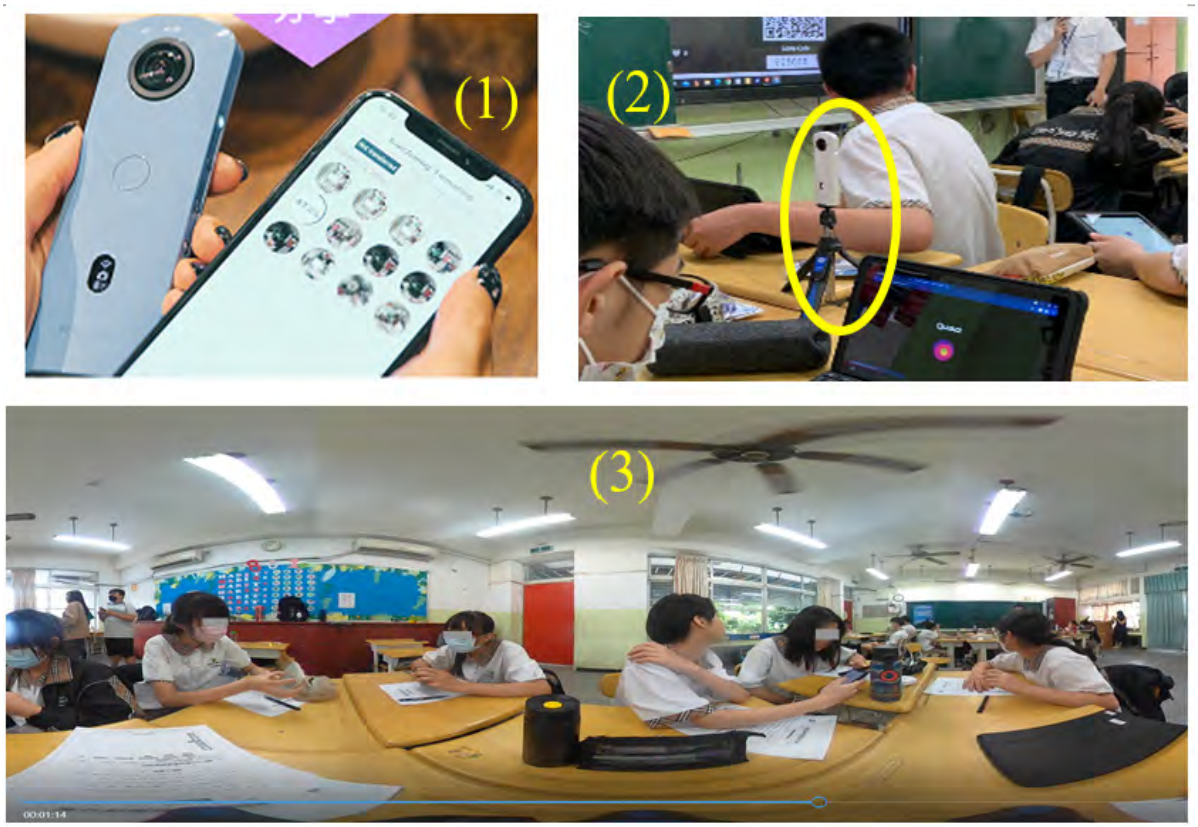

Figure 1. Operating process of a panoramic camera

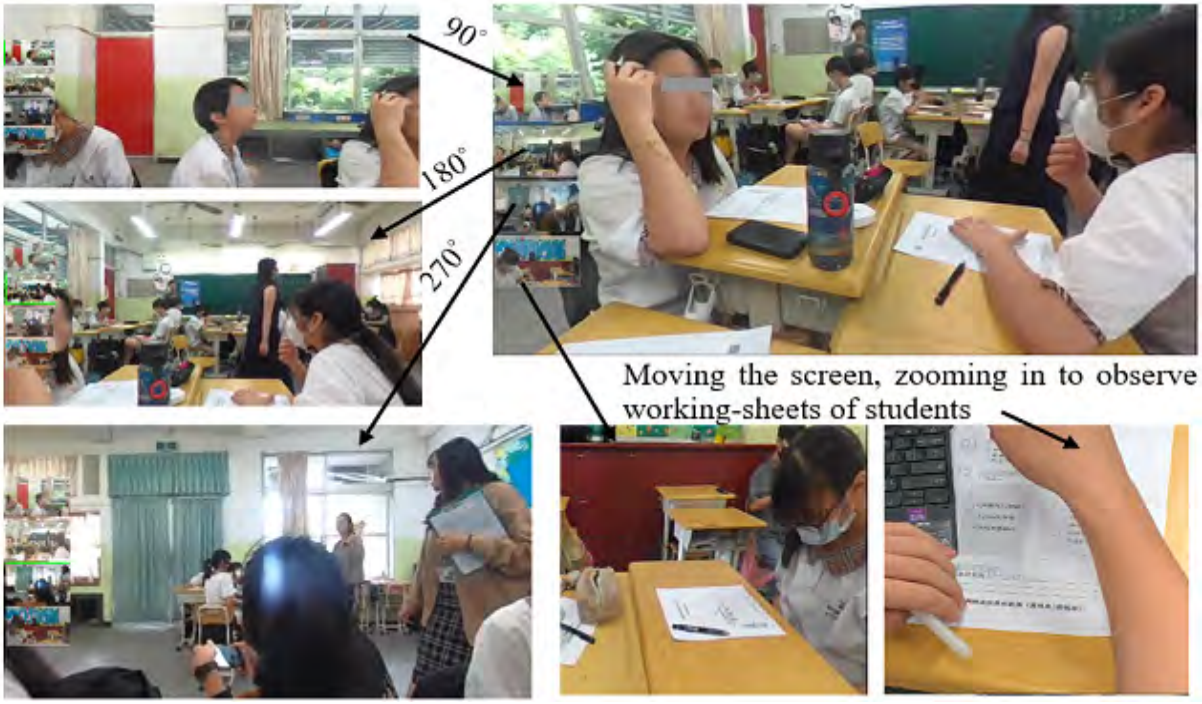

Figure 2. Screenshots of the panoramic camera recordings

1. Collaborative lesson preparation was conducted in response to the learning issues of young students.
2. Based on the results of the lesson preparation, teaching practice was implemented, with other members assisting in observing young students' learning performances during each teaching activity. Throughout this process, panoramic cameras were used to collect evidence of young students' learning behaviors.
3. After the teaching session, all members reviewed the panoramic camera footage and observation records. They then compared young students' performances with the teacher's instruction during each teaching activity, shared additional individual perspectives, and further discussed young students' issues.
4. Following the sharing and discussion, the instructors reflected on the original instructional activity design and made adjustments to its content.

However, it is recognized that TESs lack substantial teaching experience in observing young students' performance and diagnosing their learning issues. While utilizing a panoramic camera can assist TESs in acquiring specific insights into student learning problems, the extent to which they subsequently identify these issues and adjust their instructional design capabilities warrants further exploration.

METHODOLOGY

Building upon the aforementioned teacher education program for TESs, this study implemented a teacher education course titled 'Professional Teaching Practicum' from September 2022 to January 2023. In this course, participating TESs were arranged to actively participate in teaching practice, classroom observation, and post-lesson discussions within authentic classroom settings. This study developed an observation report form and a questionnaire on perceived instructional design capabilities to collect data regarding TESs' performance in this study.

Course Framework

This course was structured into two main stages, consisting of teaching practice preparation, and collaborative inquiry cycle. The first stage focuses on equipping TESs with the necessary skills and knowledge for effective teaching practices. The second stage, the collaborative inquiry cycle, involves TESs applying the above skills in real classroom settings.

The first stage

During these five weeks, I elucidated the concept of collaborative inquiry into student learning problems and its application in connecting teaching activities with student learning issues. Subsequently, I reviewed instructional activity designs that TESs had previously learned, instructing them to create lesson plans for teaching practice in junior high school classes. Following this, I used videos captured in previous research to train TESs in observing and documenting the learning performances of young students. I guided the TESs in the analysis and interpretation of student learning behaviors. Finally, I conducted training on the operation of the panoramic camera, ensuring TESs' proficiency in its use and making them aware of the aspects to observe in actual classrooms.

The second stage

This stage spanned 12 weeks, during which participating TESs were organized into teams of four to five individuals. where members alternated roles between teaching educators and classroom observers. The process commenced with TESs engaging in collaborative lesson planning discussions in a university classroom, followed by teaching practice and observation in a junior high school classroom the next week. During teaching sessions, observers documented descriptions of students' learning performances in each teaching activity and utilized a panoramic camera for supplementary recording. In the following week, each observer reviewed and organized their observational records from the panoramic camera. Subsequently, they shared their observations within their team in the university classroom. The teaching educator, after listening to the shared insights, developed an understanding of the relationship between student learning problems and teaching activities, leading to a phase of self-reflection and adjustment of their initial instructional plans. This three-week cycle repeated four times, allowing each TES to serve as a teaching educator at least once.

Participants

A total of 22 TESs voluntarily enrolled in this study's course, forming five groups. Each group was consistently paired with a specific junior high school classroom. Given the diverse academic backgrounds of the enrolled TESs, the course primarily focused on general pedagogical principles and aimed to develop instructional design capability through collaborative inquiry among TESs. The emphasis was on developing a collective understanding, rather than prescribing specific teaching methods tied to the instructional materials of individual academic departments.

This study's course is an advanced two-credit component in the Taiwanese teacher education curriculum. To enroll, TESs must have completed prerequisite courses in educational foundations, covering teaching principles, practices, and assessment. Therefore, it can be inferred that TESs in this course possess foundational pedagogical knowledge, including knowledge in designing instructional activities.

Teaching Plans Implemented by TESs during Their Teaching Assignments

In the process of designing teaching plans for their respective groups, TESs conducted preliminary interviews with the paired junior high school teachers. TESs developed thematic unit content for their self-designed instructional materials, drawing insights from interviews aimed at exploring students' curiosity about life phenomena.

The instructional themes for the five groups were: "Writing Skills in the Digital Age," "Poetry and Speech with Illustrations," "Digital Campus Tour," "Fact or Fiction? The Battle of Authenticity in Information," and "Agricultural Advocacy Ambassadors." Each group collectively discussed the learning objectives for each class session. Following that, each TES individually formulated a lesson plan for a class session tailored to the assigned learning objectives. The groups then engaged in mutual examination to establish connections between the teaching plans for each class session.

After engaging in teaching, classroom observation, and post-teaching discussions, the teaching educators, influenced by shared perspectives within their groups, deliberated potential adjustments to their initial teaching plans. The teaching educators identified specific areas for modification, marking these changes in red to highlight the distinctions in teaching activities before and after the teaching practices.

ASSESSMENT AND MEASUREMENT

Observation Record Form

As aforementioned, the focus of classroom observation should shift towards an awareness of student performance (Thompson, 2006). To collect data on TESs' observational skills and evaluate their capability to diagnose difficulties in young students' performance, this study adopts the observation method proposed by Briesch et al. (2018) known as 'evidence based on response processes' (p.50) and devises a record form titled 'Observation Record Form Based on Student Responses to Teaching Activities', illustrated in Table 1. In the presented form, the content in the 'learning objectives' and 'teaching activities' columns is derived from the teaching educator's teaching plan, while the observer supplies other information

Table 1. Observation record form based on student responses to teaching activities

Learning Objective: To	
Teaching Activities	**Descriptions of Student Learning Performance**
Activity 1	
Activity 2	
Activity 3	
Description of Student Learning Problem Diagnosis	
Teaching Strategies Adjusted in Response to the Above Challenges	

During the observation of the teaching practices, the observers focused on evaluating the performance of a specifically assigned group of young students, designated by the class teacher of a junior high school class, rather than all students in the class. This consistent observation was conducted across various instructional activities to determine the alignment of understanding with the learning objectives for young students. Subsequently, teaching strategies for enhancing the identified areas of improvement are proposed and further shared in post-teaching discussions. In this study, 22 TESs enrolled in the course were divided into five groups, resulting in a cumulative total of 76 observation records.

The researcher of this study evaluated the observation record form for each TES. In the evaluation process, the researcher developed a checklist based on a perspective involving 'the relationships between learning objectives and evidence regarding student learning performance for collaborative inquiry' (Coburn & Stein, 2010; Donohoo, 2013). Three colleagues with expertise in classroom research were invited to review and discuss the aforementioned checklist with the researcher, as shown in Table 2. The colleagues emphasized the need for greater explicitness in the distinctions among the three ranks. After the discussion, the consensus on the differentiation of levels within the checklist was as follows: the highest rank involves providing concrete evidence to explain the achievement of learning objectives, the second rank includes presenting some evidence, though insufficient to confirm the attainment of learning objectives, and the third rank pertains to responses unrelated to instructional activities or merely describing teacher behaviors.

The researcher then assessed the text in the 'Description of Student Learning Problem Diagnosis' field of Table 1. The details of the checklist and an example are illustrated in Table 2."

A Measurement Tool for Perceived Capability in Implementing Instructional Activity Designs

This study seeks to understand whether participation in this course brings about a significant enhancement in the practical ability of TESs to design teaching activities. This study developed a questionnaire focusing on TESs' perceived capability in instructional activity designs. The questionnaire content was derived from three stages of engagement during the course, namely lesson preparation, linking student learning performance with instructional activities during classroom observation, and adjusting teaching plans based on post-discussion.

The questionnaire totaled 12 questions, comprising four questions for each stage. After formulation, the questionnaire underwent a review by the aforementioned colleagues to assess its appropriateness. After undergoing essential revisions, the questionnaire was formally endorsed as the survey instrument. The pre-test was conducted following the first cycle of observations and discussions, whereas the post-test was carried out upon concluding all observation and discussion cycles.

With only 22 TESs involved, fewer than 30, this study employed a non-parametric statistical analysis, specifically the Wilcoxon signed-rank test, for pre- and post-test evaluations. The results of this analysis, combined with data on TESs' diagnostic

Table 2. Checklist for TESs in diagnosing student learning difficulties

Ranks	Descriptions	Examples
2	Presenting concrete evidence (e.g. written content, spoken discourse, and operational actions) based on students' actual performance to determine the attainment of learning objectives. Identifying the factors contributing to the achievement or non-achievement of learning objectives and their correlation with the corresponding instructional activities.	In the second column of the learning worksheet, the student's notation 'can trust him and provide assistance' suggests an inability to recognize the characteristics of false information, indicating a level of comprehension below the learning objectives. The inferred reason could be attributed to errors during Activity 2, where students practiced discerning the authenticity of information by reading lengthy articles.
1	The depicted student performance could not sufficiently provide a comprehensive confirmation of the attainment of learning objectives, thereby hindering a precise identification of the instructional activities contributing to students not meeting these objectives	The students did not pay attention to listening during the learning process, leading to inaccuracies in the exercises on the learning sheet and indicating a deficiency in their ability to discern misinformation. The questions on the learning worksheet were too difficult, and students were unable to answer the more challenging ones.
0	The content of the described student performance exhibits limited relevance to the learning objectives, focusing solely on the instructor's behaviors, materials, and spoken content. This limitation makes it challenging to diagnose the source of students' learning difficulties within specific instructional activities.	The teacher provided an extended duration for students to work on the learning sheet, leading to some students engaging in conversations after completing their own sections. There was an excess of information displayed on the electronic whiteboard, with small font size, making it difficult to read.

abilities in identifying student learning issues, helped determine the perceived changes in the instructional design capabilities of TESs. The two examination tools provided additional supports for the feasibility of the teacher education program of this study. The content of the questionnaire items along with the analytical results is presented in Table 3.

RESULTS AND DISCUSSION

Changes in Diagnostic Capabilities from Four Cycles of TESs' Observation Reports

A total of 22 participants were divided into five groups, with each teaching practice session accommodating five individuals as part of the program in this study. The remaining 17 participants engaged in classroom observation activities. The researcher reviewed the observational reports of these 17 individuals in accordance with the rubrics outlined in Table 2. In each cycle, there were 17 observational reports, with a maximum summed score of 34 points based on the established grading standards. Subsequently, the researcher analyzed and calculated the scores from the four cycles, presenting the findings graphically in Figure 3.

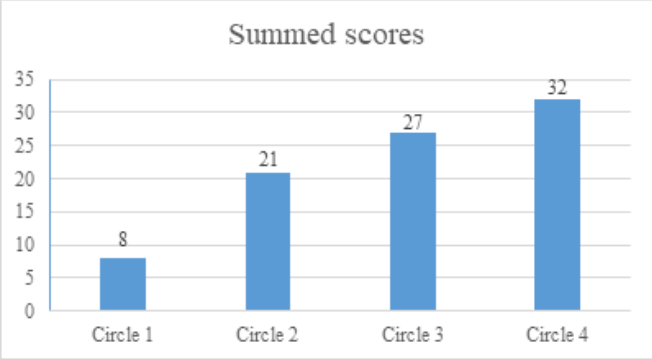

Figure 3. Trend in observation report grading scores

The analytical result revealed in Figure 3 illustrates an improving trend across the four cycles of observation reports. In the first cycle, the average score was only approximately 0.47 (8 scores /17 persons), indicating that the majority of TESs primarily focused on teaching educators' performance in teaching processes, neglecting consistent descriptions of young students' performance and their relationships with learning objectives, as descriptions outlined in the rubrics. The TESs encountered challenges in diagnosing students' learning problems within the teaching processes. Before the second cycle, the researcher emphasized to TESs the importance of focusing on learning objectives and detailing observations of young students' behaviors in each teaching activity. Subsequently, in the second and third cycles, a significant enhancement was noted, with average scores per person approximately 1.24 (21 scores /17 persons) and 1.59 (27 scores /17 persons), respectively. However, despite TESs paying attention to the achievement of learning objectives, their diagnostic accuracy was insufficient. This was because diagnosing young students' learning issues requires synthesizing overall performance across all teaching activities, rather than concentrating solely on one or two observed behavioral instances of designated students for observation. Potentially, the aforementioned diagnoses regarding learning issues were drawn based on personal subjective perspectives instead of sufficient empirical evidence. Afterwards, the researcher provided further guidance, emphasizing that the diagnoses of learning objectives should be based on evidence from students' substantial behaviors observed through the practical implementation of multiple teaching activities. Subsequently, TESs achieved scores above 1.88 (32 scores /17 persons) out of a maximum of 2 points in the fourth cycle.

According to the aforementioned study findings, during the initial implementation cycle of this study's program, the performance of TESs exhibited similarities with the findings of Bjuland and Mosvold (2015), revealing challenges in diagnosing learning issues through specific student learning performances. However, drawing insights from the approach proposed by Kramer et al. (2021), the researcher incorporated guidance and practical illustrations. As a result, TESs' performance improved, enabling analysis and diagnosis based on student performance data. Accordingly, the effectiveness of implementing this study's program and its associated model in enhancing the development of TESs' capability to diagnose student learning issues could be asserted. This study finding addressed the first research question by demonstrating an improvement in TESs' capability to diagnose young student learning issues following their participation.

Changes in Perceived Capabilities in Implementing Instructional Activity Designs

Concerning changes in their perceptions of instructional design capabilities, the pre- and post-test results are presented in Table 3.

According to Table 3, the analytical results reveal statistical significance in perceived capabilities for 'lesson preparation,' 'linking student learning with teaching practice during classroom observation,' and 'adjusting lesson plans based on post-discussion,' with corresponding *Z*-values of -4.025, -3.535, and -3.536, respectively. In each case, the *p*-value was < 0.05.

The participating TESs of this study, following teaching practices and engaging in post-teaching discussions with group members, adjusted their original lesson plans, in accordance with the perspectives presented by Butler and Schnellert (2012). According to the analysis results in Table 3, the participating TESs not only experienced a changing perception of the relationship between student learning issues and teaching activities but also recognized the potential impact of instructional activity design on students during course preparation and lesson plan adjustments. Moreover, their adjustment of teaching activities within the teaching plans was grounded in the assessment of student learning because observations made by other members of the group during class, with the assistance of panoramic camera footage, provided evidence. Especially, similar to the viewpoint presented by Cross et al. (2022), the use of panoramic cameras in teacher education and professional development has demonstrated a positive impact on enhancing teaching practices. Subsequently, during post-observation discussions, they engaged in in-depth dialogues regarding student learning objectives based on observational reports, utilizing the panoramic camera recordings. They further recognized the contents of teaching activities that could be adjusted. Consistent with the findings of studies (Gómez et al., 2019), engaging in reflection with peer assistance proves to be more beneficial than solitary reflection. In other words, compared to individual reflection, collaborative reflection elicited more reasoning and fostered the development of intricate knowledge. Consequently, there was evident change in their perception of capabilities for instructional activity design. Based on the aforementioned analysis and discussion, the findings of this study addressed the second research question, demonstrating that

Table 3. Pre- and post-test results for perceived capabilities in instructional activity designs

Facets and Items	Pre-test		Post-test		Z value
	M	SD	M	SD	
Facet 1: lesson preparation	3.42	0.54	4.48	0.40	
I am aware of the purposes of teaching activities; thus, I feel capable of designing a well-structured teaching plan.	3.62	0.67	4.48	0.51	-4.025*
I am acquainted with various teaching methods; consequently, I feel competent in applying these methods to create an effective teaching plan.	3.43	0.60	4.33	0.73	
I am knowledgeable about diverse assessment methods; as a result, I believe I have the capability to incorporate these methods into designing a proficient teaching plan.	3.05	0.67	4.48	0.51	
I am familiar with students' learning issues; therefore, I believe I am capable of designing an teaching plan that improves learning outcomes.	3.57	0.93	4.62	0.50	
Facet 2: linking student learning with teaching practice during classroom observation	3.42	0.54	4.48	0.40	-3.535*
During classroom observations, I feel competent in identifying whether a particular teaching activity can enhance students' learning engagement.	3.62	0.67	4.48	0.51	
During classroom observations, I feel competent in recognizing when students encounter difficulties in a specific teaching activity.	3.43	0.60	4.33	0.73	
During classroom observations, I feel capable of identifying which teaching activities contribute to students not achieving the learning objectives.	3.05	0.67	4.48	0.51	
During classroom observations, I feel competent in connecting appropriate teaching strategies based on students' learning difficulties.	3.57	0.93	4.62	0.50	
Facet 3: adjusting lesson plans based on post-discussion	3.61	0.71	4.58	0.46	-3.536*
Following this cycle of classroom observations and post-discussion, I have developed the capability to assess students' learning outcomes based on learning objectives.	3.14	0.66	4.62	0.50	
Following this cycle of classroom observations and post-discussion, I have acquired the skills to structure multiple teaching activities based on learning objectives.	3.67	0.80	4.43	0.68	
Following this cycle of classroom observations and post-discussion, I possess the capability to consider teaching activity in response to students' learning problems.	3.76	0.94	4.71	0.46	
Following this cycle of classroom observations and post-discussion, I have developed the capability to adjust teaching methods based on students' learning problems.	3.86	0.97	4.57	0.51	

the teacher education course and associated practices effectively enhance the TESs' capabilities in designing instructional activities.

This study recognized that previous teacher education programs struggled to enhance TESs' ability to diagnose young students' learning issues and improve their instructional design capability. To address this issue, a new approach to teacher education integrating collaborative inquiry with the use of panoramic cameras was developed and implemented. According to the aforementioned study findings, this study demonstrated the feasibility of incorporating this course within teacher education programs. Specifically, the observation method in this course relied on evidence from student performances, partly captured with panoramic cameras, and their subsequent analysis. This approach aims to improve traditional observation methods. Over a semester-long implementation involving four cycles of practice and analysis of observation reports, the new method of classroom observation in collaborative inquiry has proven effective in enhancing TESs' proficiency in diagnosing learning issues and refining their instructional design capabilities.

CONCLUSION AND REFLECTION

This study integrated the concept of collaborative inquiry with the utilization of panoramic cameras, subsequently developing a teacher education program. Within this program, collaborative inquiry served the purpose of enabling TESs to more effectively identify and address student learning problems in group settings compared to individual approaches. The incorporation of panoramic cameras was intended to capture student learning issues, providing tangible evidence for post-discussions on student problems. This method of collaborative inquiry enhances TESs' comprehension of the correlation between instructional activity design and student learning performance, guiding them in formulating teaching activities based on student learning issues. This new approach also improves upon the traditional method whereby TESs adjust their teaching under the guidance of experienced mentors after teaching.

After implementing the aforementioned program for one semester, this study concludes that the diagnostic abilities of prospective teachers in identifying young student learning problems have indeed improved. Additionally, a noticeable positive change was observed in their perceived capabilities for designing instructional activities. Overall, the course framework proposed in this study demonstrates feasibility in the context of teacher education.

The researcher's self-reflection indicates that the efficacy of this proposed framework is likely rooted in the substantial effectiveness derived from the collaborative inquiry concept and the application of panoramic cameras. Initially, TESs may be influenced by the traditional practice of observing and watching instructors during classroom observations. The researcher introduced video footage of student learning, particularly segments where learning issues arose, before the second cycle. The visualization of content facilitated TESs in contemplating the impact on instructional activity design. Subsequently, these TESs engaged in post-observation group discussions, collectively deliberating on student learning

issues and potential improvement strategies. This process significantly contributed to the aforementioned learning outcomes.

Nevertheless, a consideration for further refinement is that, following the diagnosis of student learning issues, it is challenging to ascertain the effectiveness of the instructional strategies proposed by teacher education students in response to these learning problems. This limitation may result from their relatively limited teaching experiences. Teacher education courses in the future could continue to provide opportunities for TESs to diagnose learning issues among young students within their own teaching. They could establish correlations between student learning challenges and instructional activity design. Recognizing the benefits of observing young students, diagnosing learning issues, and integrating feedback from classroom observers into their instructional designs, they are prepared to enhance student learning outcomes and improve teaching quality in their future roles as educators. This approach, compared to traditional methods of learning teaching techniques solely from expert teachers, might more effectively enhance teaching efficacy.

In the scholarship of teaching and learning within higher education, researchers often encounter similar challenges to the TESs' learning of this study, especially when preparing undergraduate students for professional roles, such as those in nursing or speech pathology. This study, under discussion, utilized panoramic cameras to provide TESs with abundant opportunities for thorough evidence collection, thereby facilitating a nuanced reflection on pedagogical practices. Similar pedagogical investigations could explore the effectiveness of adopting the approach utilized in this study, particularly in enhancing university students' performance and professional efficacy through the presence of ample evidence.

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