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Mathematics Teachers in Teaching 4C Skills: School-University Perspective

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ABSTRAK

Pada abad ke-21, guru pendidikan dituntut untuk mencari cara-cara baru untuk meningkatkan kualitas guru matematika. Namun faktanya terlihat dari tes PISA menunjukkan prestasi siswa Indonesia selalu rendah. Selain itu, OECD melaporkan bahwa hanya 1% siswa di Indonesia yang mampu menjawab pertanyaan pada tingkat rendah. Tujuan penelitian untuk mengidentifikasi dan mengetahui apa saja yang menghadap para pendidik guru dalam mempersiapkan guru matematika dengan keterampilan 4C dan mengetahui solusi dalam kesulitan 4C. Metode penelitian dengan kualitatif studi kasus eksploratif dengan desain studi kasus tunggal. Subyek adalah para guru di sekolah dan para calon guru di perguruan tinggi. Teknik pengumpulan data dengan dokumen dan wawancara. Sepuluh calon guru perspektif universitas dan sepuluh guru dalam jabatan untuk perspektif sekolah. Teknik analisis datanya dengan menggunakan metode analisis komparatif konstanta. Hasil penelitian ditemukan Lima tantangan umum: kurangnya kemampuan dan motivasi belajar di kalangan calon guru, tantangan pedagogi, dan kurangnya kapasitas dan pemahaman konsep keterampilan 4C di kalangan pendidik guru, kurangnya program dan fasilitas pendukung, dan tantangan politik. Temuan lain, kapasitas guru merupakan dua hal yang menjadi perhatian utama, universitas harus menerapkan sistem pembelajaran baru yang dinamis untuk membekali lulusan guru matematika dengan sumber daya yang mengajarkan keterampilan 4C secara inovatif.

ABSTRACT

In the 21st century, teacher education is required to look for new ways to improve the quality of mathematics teachers. However, the facts seen from the PISA test show that the achievement of Indonesian students is always low. Additionally, the OECD reports that only 1% of students in Indonesia are able to answer questions at a low level. The research aims to identify and find out what teacher educators face in preparing mathematics teachers with 4C skills and knowing solutions to 4C difficulties. The research method is a qualitative exploratory case study with a single case study design. The subjects were teachers at schools and prospective teachers at universities. Data collection techniques using documents and interviews. Ten prospective teachers from a university perspective and ten in-service teachers from a school perspective. The data analysis technique uses the constant comparative analysis method. The research results found five common challenges: lack of learning ability and motivation among prospective teachers, pedagogical challenges, lack of capacity and conceptual understanding of 4C skills among teacher educators, lack of supporting programs and facilities, and political challenges. Another finding is that teacher capacity is the two main concerns; universities must implement new, dynamic learning systems to equip mathematics teacher graduates with resources that teach 4C skills innovatively.

1. INTRODUCTION

The impact of the emergence of global consensus regarding the need to include 21st century skills in the education curriculum, increasing critical thinking and problem solving abilities, creativity, communication and collaboration (4C) among students has changed everything in the world of education, in particular. in mathematics learning. 4C skills are very important in modern life, especially for entering the world of work and facing a complex world (Ağaoğlu & Demir, 2020; Sanjayanti et al., 2020). Communication skills that allow participants to capture reactions directly. If an educator must teach academic skills and cooperation skills. Critical thinking skills can be defined as a more complex form of thinking activity that involves analyzing more specific ideas while developing them more perfectly. The skill of creative thinking is the ability to link various objects and knowledge into a solution for a particular

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purpose. With this change, it is hoped that every student will be able to communicate and collaborate to solve problems critically and creatively with people all over the world (Tang et al., 2020). Recommending the 4C skills in daily teaching practice is highly desirable due to its long-term benefits (Nousheen et al., 2020; Taufiqurrahman, 2023). Therefore, skills are always part of the curriculum and daily teaching. Integrating 4C skills in the mathematics classroom can be a complex process that requires careful planning, teacher training, and teacher assessment (Sukmawati & Ghofur, 2023). In its implementation, teaching 21st century skills requires a holistic approach that considers content, pedagogy, assessment, teacher training, budget and systemic regulations. However, many educators are still determining the definitions, processes, and assessments used to teach 21st century skills and are overwhelmed by the scope and pace of educational reform (Okay & Fernandes, 2020).

Most education systems need help to solve these problems, and there is no national consensus on effective integration, assessment, and quality assurance (Marchiori & Mendes, 2020; Tulljanah & Amini, 2021). However, each educational organization provides recommendations to overcome this problem, including teachers having the ability and opportunity to collaborate in creating a learning environment, meeting the learning needs of certain student groups, developing teachers' professional skills, and teaching in teams to support students to develop globally. capacity. Each requires good and intensive teacher preparation. Education in Indonesia requires a rapid response to meet the demands of the 21st century. This is important because the mathematics achievement of Indonesian students is still low and has become a concern over the last decade (Muhtadi et al., 2022). This can be seen from the current PISA test which shows that Indonesian students' performance is always low, with average scores of 375, 386, and 375 respectively in the 2012, 2015, and 2018 tests. In addition, the OECD reports that only 1% students in Indonesia who were able to answer questions at levels five and six, which assess several 4C skills such as critical thinking and problem solving. In comparison, student performance at level 2, which evaluates low-level thinking, was much higher at 28% (Sugandi et al., 2021). A local study conducted by (Tanudjaya & Doorman, 2020) indicating that poor performance continues.

Given these educational issues, it is important to bring together all aspects of an effective teacher education model in the 21st century to provide teacher training at an international level. This action is needed to ensure teachers become individuals who are aware of all the problems around them, create solutions, and take a stand (Ryan & McAllister, 2020). However, prospective teachers must be adequately prepared to face the demands of today's teaching and learning environment, by emphasizing the 4C skills (Burbules et al., 2020; Elisa & Wiratmaja, 2019). The implementation of the teaching process in Indonesian universities is different with the aim of cultivating 21st century skills in prospective mathematics teachers (Kamil et al., 2020). The instructor's learning experience must meet 21st century requirements. Most teacher educators must better understand 21st century skills, resulting in adequate 21st century training for student teachers during their initial education programs. Teachers face challenges in acquiring the necessary content and pedagogical knowledge to teach the 4C skills in mathematics education programs (González-pérez & Ramírez-montoya, 2022). In addition, lecturers' pedagogical competence in teaching 4C skills is not practiced enough to deserve policy direction (Sanjayanti et al., 2020; Taufiqurrahman, 2023). As a result, the performance of prospective teachers is at a low or medium level (EFENDİ et al., 2020).

This shows that initial teacher education programs are inconsistent, where there is a disconnect between theory and practice (Meij et al., 2022). In other words, universities in Indonesia are producing mathematics teachers who are not ready to meet the demands of the 21st century. If these students become teachers, they will likely perpetuate ineffective teaching practices, resulting in a cyclical pattern of poor performance (Carpenter et al., 2020). Shows that teacher education institutions in Indonesia have difficulty preparing future teachers to teach 4C skills. Previous research findings stated that by applying the 4C skills, students can solve problems on their own (Parmini et al., 2023). Considering the gap between theory, expectations and reality on the ground in educational problems, it is very important to unite all aspects of an effective teacher education model in the 21st century to present teacher training at the international level. This research is urgently carried out to examine and identify the challenges faced by teacher education institutions in providing situations for prospective mathematics teachers, who are prospective teachers, in order to form a reasonable understanding of 21st century learning. The aim of this research is to analyze school teachers in teaching 4C skills. This study contributes to existing knowledge by providing several identified barriers that policymakers in Indonesia must overcome to encourage educators to integrate 4C practices in mathematics teaching at school and university levels.

2. METHODS

The research method uses a qualitative research approach, namely an exploratory case study to determine the challenges faced by teacher education institutions and schools in preparing students with 4C skills and knowledge. The research design is a single case study with several embedded units from two educational institutions represented by university lecturers and school teachers. The context is 4C skills-based mathematics teaching, and the case relates to the challenges educators face in schools and universities. The sampling technique using purposive sampling is also called judgmental, selective, or subjective (Cash et al., 2022). The subjects in this research were ten teacher educators representing the university perspective and ten permanent teachers representing the school perspective who were invited to participate in interviews. The selection of participants was based on the inclusion criteria of having more than five years of experience teaching mathematics. Voluntarily agree to participate in research and be from an educational institution. A summary and description of the participants' experiences is presented in Table 1.

Table 1. The Summary and Description of the Participants' Experiences

Teacher Educators Group				In-Service Teacher Group			
Pseudonym	**Age group**	**Teaching Year**	**Current Status**	**Pseudonym**	**Age Group**	**Year Teaching**	**At the Moment Status**
TE01	31-35	7 years	Teacher	ST01	55-60	25 years	Teacher
TE02	31-35	9 years	Teacher	ST02	35-40	15 years	Teacher
TE03	31-35	7 years	Teacher	ST03	35-40	16 years	Teacher
TE04	31-35	8 years	Head of mathematics education department	ST04	41-45	16 years	Teacher
TE05	36-40	7 years	Head of mathematics education department	ST05	61-65	23 years	Teacher
TE06	36-40	7 years	Head of mathematics education department	ST06	35-40	14 years	Teacher
TE07	31-35	9 years	Teacher	ST07	51-55	26 years	Teacher

Data collection techniques use instruments. Primary data collection instrument that plays an active role in making certain decisions regarding the conduct of in-depth semi-structured interviews. The interview framework, guided by research questions, describes the challenges educators face in equipping their students with the 4C skills and reviews literature on the application of 21st century skills in the teaching and learning process. Ten initial questions were generated in four dimensions of challenges found from the literature review, including two questions on the conceptual understanding dimension, two questions on the belief dimension, three questions on the pedagogical approach dimension, and three questions on the support dimension. In addition, participants were asked to provide a clearer description of their difficulties. Open questions highlight the aim of understanding and describing the essence of teaching in universities and schools. Open questions clarify the focus, namely understanding and elaborating on the essence inherent in teaching at universities and schools. In-depth interviews are used to explore and collect experience material. Because participants were located across the Region, the online Zoom platform was used to supplement the face-to-face interviews. Analysis of research data. The data collected for this exploratory research is purely qualitative and comes from interview transcripts and learning implementation plans. Constant comparative analysis is applied for comprehensive description and careful analysis of data. The analysis procedure is presented in Table 2.

Table 2. The Summary of Qualitative Data Analysis

Stage	Job Description	Results
Starting from the process	Transcribe audio tapes Identify recurring ideas	Interview transcripts are ready for analysis

Stage	Job Description	Results
Stage 1: Inductive category coding	Create temporary categories based on 'similar and feels like criteria'.	Initial list of codes
Stage 2: Refinement of categories	Making the inclusion rule a propositional statement	List of categories with propositional statements
Stage 3: Relationship exploration cross categories	Combine categories into several broad categories	The final group of categories are stand-alone propositions and outcome propositions
Stage 4: Data Integration	Search for meaning in data	Fusion

(Agha et al., 2020)

The data analysis process in the two case units of teacher educators and school teachers is described as follows: Stage 1; Inductive categorization. This stage involved careful reading of the interview transcripts to identify initial recurring codes and themes. This produces a tentative code list. NVivo 20 software was used to facilitate the coding and theme creation process (Olapane, 2021). In the second step, overlapping concepts/themes should be combined and assigned emergent codes, aiming to create provisional codes to group themes. Keeping comprehensive records of the thought process behind coding helps identify areas that might benefit from reorganization. For the case of teacher educators (unit 1), 25 codes were identified after the first five interview transcripts were analyzed. Before moving on to the next set of transcripts, the following five transcripts led to the addition of new codes. After each analysis session, and especially after adding new codes, the entire text was re-examined to compare the coded texts to determine whether they could be associated with other codes. This process of constant comparison results in a close relationship between code and text. Stage 2, category upgrade. Once the initial development of codes and categories is complete, reduction, merging, and creation of subcategories begin. This process required examining coded and uncoded segments to determine whether there were overlapping themes.

Therefore, this procedure can be divided into three steps: The initial stage involves grouping all similar themes into one provisional category. Next, the researcher read the data again and obtained general principles. After the temporary regulations are prepared, a comparison and revision process is carried out. Stage 3; Exploration of Cross-Category Relationships. This stage further refines the categories by grouping them under one umbrella. Categories that have the same characteristics are combined to form more significant categories. The relationship analysis process utilizes the NVivo 20 coding matrix feature (Tixier et al., 2016). Stage 4; Data integration. This phase requires synthesis, in which the researcher investigates the themes developed to understand the significance of the data. Relevant categories can be grouped based on the research questions asked to decipher the significance of the data. This will create a complete understanding and pattern of meaning. Then, the analysis stage concludes everything. At this stage five themes were produced for the case of teacher educators and school teachers. The two cases have four themes in common, and only one is different. The similarities and differences between themes generated from the case units are presented in Table 3.

Table 3. The Comparison of Themes Generated by Teacher Educator Cases and School Teacher Cases

The Case of Teacher Educators	School Teacher Case
Lack of learning ability and motivation for prospective mathematics teachers	Lack of student ability and character
Pedagogical challenges	practical challenges,
Lack of teacher educators' ability and understanding of the 4C skills concept	Lack of teacher competence and motivation

Four trust criteria, namely credibility, dependability, transferability, and confirmability (Prochner & Godin, 2022). This includes a) checking the transcript for errors: this step aims to ensure that the interview is transcribed with low inference and presents only what the respondent has said, involving reading and re-reading the transcript several times to check for errors, conclusions and interpretations. Written rather than an ordinary translation, consistent coding: researchers use guidelines in comparing data systematically and continuously to ensure consistency and thereby create reliable coding patterns, inter-coder reliability or cross-checking: this method is used to develop a coding scheme that can reproduced(Bauwens et al., 2022).

3. RESULT AND DISCUSSION

Results

The first finding is the lack of student learning ability and motivation. Students' inability and lack of motivation to learn mathematics is one of the most significant obstacles facing teacher institutions in preparing prospective teachers to teach 4C skills. In the case of teacher educators, eight participants reported needing assistance to teach mathematics subjects with 4C skills due to lack of talent and motivation of their students, especially from private universities. They stated that to be able to teach 4C skills-based mathematics learning, pre-service teachers need to master 4C skills. However, in reality their understanding of basic mathematical concepts is still limited. Students cannot think critically and creatively in solving mathematical problems if they do not master basic concepts or mathematical principles. Students come from remote areas and cannot enter state universities in the capital, their abilities are below average even though there are one or two of them who are above average. Their lack of understanding of basic mathematics is one factor. Another participant [TE03] added that "students with low cognitive abilities easily give up when solving difficult mathematics tasks that require them to think critically because they are not used to solving such problems at school". This participant also added that "if I saw it, maybe it was a basic understanding of mathematics that caused this condition. For example, when they don't understand previous concepts, even though in many cases we teach the new concepts above, they still don't understand. Even if I force them, they still don't understand. One factor is that basic mathematics skills are still weak. Students whose mathematical concepts are weak have difficulty in critical thinking or other C skills. It takes a lot of time to teach them. We have to educate them slowly, unlike students at certain state universities, they learn quickly while my students don't. There may be a correlation between poor performance and 4C skills. This is because critical and creative thinking requires reasoning and understanding basic concepts. Problems with student abilities are also seen in the case of school teachers. Six teachers experienced difficulties in teaching 4C skills due to their students' low abilities, including mastering basic knowledge such as the concepts of multiplication and division and only being able to solve procedural problems.

The second finding, pedagogical challenges. Teacher educators believe that teaching the 4Cs skills to prospective mathematics teachers is important. Teachers have implemented 4C skills in their courses. However, the seven people admitted that their pedagogical knowledge to teach these skills to their students was still lacking. Teachers conceptually understand the 4C skills but need to learn how to teach them. So, both students and educators still have a lot of work to do regarding teaching 4C skills. From a lecturer's perspective, having difficulty selecting or assigning appropriate math problems for my students to develop their 4C skills. Many people say it's HOTS, even though it's not HOTS. This issue is also problematic because lecturers must have the ability to convey something that is easy to understand, must be able to explain from difficult language to easy and simple language. It is difficult to give a precise analogy, and we cannot use the language in this book directly. Teaching 4C skill-based mathematics subjects to students with different capacities is difficult. We must consider what assignments we should give to students with low and high levels of achievement. They must receive special treatment. In class, their skills are pretty spread out." Within this theme, pedagogical issues have been identified as an additional challenge in preparing pre-service teachers to teach the 4C skills. Although educators recognize the need, understand the concept, believe in its importance, and are willing to apply it in their teaching, they struggle with pedagogical issues such as selecting mathematical problems that fit the development of 4C skills, and providing analogies to explain them. lesson content. It is understandable, designing assignments for students of varying ability levels, and the time-consuming nature of course delivery. In contrast, pedagogical challenges are not as significant for school teachers. They face more problems during the implementation process, which we call practical challenges. This includes difficulties in forming groups, managing learning, time constraints, use of media, and applying pedagogical approaches.

It is difficult to form heterogeneous student groups because of the large diversity of students. The number of students who have the lowest achievement is greater than the number of students who have the highest achievement. The group discussion will probably become a vacuum when I put them in the same group. If this happens then learning will be delayed and cannot be completed. Regarding the pedagogical approach and time constraints of teachers using problem-based learning (PBL), asking students to solve problems at the beginning, does not work at all. Due to their lack of interest in learning, I was forced to switch to a discussion approach. With limited time, I believe the PBL steps are almost complete. Among these problems, learning management was completely unexpected, different from previous studies. Teachers experience difficulties in implementing 4C skills learning because of the time allocation for mathematics classes and other subjects. The teacher's teaching practice states that mathematics classes are usually scheduled in the afternoon along with other challenging subjects such as

science, so students get tired easily, I think this has an impact on the implementation process as well. Mathematics classes are taught by several teachers using different approaches. Most require students to take notes and complete exercises. This condition is also one of the common challenges in our schools, namely the daily teaching practices of teachers, students have to follow ten subjects taught by ten different teachers, eight of whom prefer students to remain seated and silent. When taking notes and doing exercises or homework. Only two teachers prefer their students to study in groups, discuss and present creatively and critically. Therefore, improving 4C skills among students will be difficult if many teachers hold such views. It can be concluded that school teachers experience difficulties in terms of practice when implementing 4C skills-based teaching.

The third finding, teacher educators' lack of competency and conceptual understanding of the 4C skills. Another theme from the analysis of teacher educator case data was incompetence and deficiencies. Conceptual understanding of 4C skills among teacher educators. Only four out of ten participants were able to explain comprehensively the concept of 4C skills and the demands of 21st century learning. However, all of them were of the opinion that prospective mathematics teachers must be equipped with 4C skills because the current school curriculum requires these skills, thereby triggering them to make every effort possible to implement learning-based learning. 4C skills. Eight participants acknowledged that their competency in teaching 4C skills-based teaching in their courses required improvement. They are dissatisfied with their efforts to help their students acquire these skills. Based on the results of interviews, students are asked to communicate and collaborate but forget to provide them with learning activities that stimulate the development of these skills. Students are required to think critically and creatively, but my instructions remain the same. My teaching skills need to be improved to help them develop the 4C skills. The challenge now is to develop my teaching competence. Educators' knowledge and teaching skills must be improved in order to provide learning that meets the needs of their students. Teaching skills are one of the determining factors in assisting pre-service teachers in developing 4C skills. In addition, one of the senior teacher educators who is the head of the mathematics education department said that in general, there were no challenges for me. However, with so many young lecturers and senior lecturers in our department, this is a challenge in itself. These senior lecturers are resistant to change. Meanwhile, of course the juniors don't have much experience, so we need to train them.

This finding can be interpreted as meaning that the capacity of teacher educators (lecturers) in implementing 4C skills-based courses is an obstacle. factors in helping pre-service mathematics teachers develop skills to teach the 4Cs skills. Six teachers acknowledged that their understanding of the 21st century skills framework, particularly the 4C skills. Based on the results of interviews, teachers stated that they must have the capacity because teaching in the future will be more challenging. If they miss out, students might lose interest in the lesson. Teachers have to read a lot; they are not temporary learners, but lifelong learners. If the teacher is not smart it can have an impact on the students. Teacher ability is important, especially for me who doesn't have an educational background because my degree is pure mathematics, so I have to study pedagogy, teaching, models myself. Teachers have difficulty understanding theory so there is a need for a coaching program. Teacher motivation in implementing 4C skills-based learning is also problematic in this regard. Lack of enthusiasm for student learning makes teachers lose motivation. Student interest in learning is low, a challenge I have faced over two decades of teaching. This condition makes me unmotivated. The students weren't interested, I wasn't interested either. When students have lost interest, we have to be more creative. It seems that my knowledge alone is not enough. "A lot of effort has to be made." teaching profession. In this regard, university mathematics teacher training programs must emphasize teaching the 4C skills and innovating so that future mathematics teachers can meet the current demands of 21st century teaching and learning.

The fourth finding, lack of supporting programs and facilities. Discussions with teacher educators revealed the need to provide support in the form of facilities and professional development programs. Due to a lack of support, resources, and capacity, they cannot adequately prepare teacher candidates to teach the 4C skills. All teacher educators agreed that participation in professional development (PD) programs such as workshops, webinars, conferences, and discussions with learning communities can help them deliver teaching based on the 4C skills. However, support for PD programs provided by mathematics education departments, faculties or universities is still lacking. Based on the results of the interview, I did not see any support from my university to teach 4C skills. They focus on current policies regarding freedom of study and university freedom, where students are encouraged to participate in exchange or student mobility. Currently the lecturer competency development program is still low, possibly due to several reasons. For example, if a lecturer wants to develop their abilities, we should look for free webinars or something else. resource. Self-development is mandatory, so if there is a workshop, the university assigns us to take part. Even though the workshop is not specifically related to 4C skills, and yes, so far there has been no workshop related to 4C skills conducted by our

department/faculty/university. Specifically for the application of 4C skills, there are none yet. However, since 2018 I have focused my research on higher order thinking skills (HOTS) which include aspects of thinking such as critical thinking which is part of the 4C skills. Well, I once attended a workshop related to HOTS. One of the participants from one of the PTNs represented by [TE09] stated that the Faculty views lecturers like intact glass, if there is a workshop, most lecturers don't want to. take part by saying "Oh, we already know that, workshop, so there's no need for that. They seem to know everything." Apart from that, learning environments that support their professional development, such as teaching communities, especially lesson study, are rarely found in their environment. Information regarding the implementation of lesson study in higher education is new to them. Nine participants reported the existence of a lesson study community. there are none at the university, there are only face-to-face and online lecturer forums to discuss all problems in the teaching and learning process.

Data analysis shows that the availability of university facilities such as learning resources, IT equipment, and other learning facilities hampers the ability of teaching staff to teach 4C skills. This condition especially occurs in private universities, the unavailability of facilities is a problem because fewer and fewer students have laptops or smartphones. technology-based teaching to teach 4C skills in the classroom, these things are necessary. Educators have attended useful workshops, but are unable to register due to limited facilities. Our facilities at private universities are not comparable to state universities, as a lecturer I occasionally prepare lessons to improve students' 4C skills two weeks in advance. Try hard because learning facilities are inadequate to support students in developing 4C skills. Students have difficulty finding relevant references themselves, perhaps because most references are written in English, and there are rarely sources in Indonesian. Reading is still limited. Likewise with lecturers, we must provide relevant references. Learning resources, such as books on teaching and learning 21st century skills, were not available; there are books that are HOTS, but the content is not HOTS. This theme describes the challenges of teacher educators in supporting their students to develop the capacity to teach 4C skills due to limited professional development programs and facility support. Understanding context-specific teaching practices and meaningful approaches to support educators' professional development is a significant barrier to achieving desired development. This obstacle is also a problem for school teacher educators. The lack of TPD programs and facilities can be seen in school teacher data. This theme was generated from two categories with eleven codes. All participants (10) said that they needed support to integrate 4C skills in everyday mathematics classes because the TPD program carried out by the district education office and mathematics teacher forums was not specific for 4C skills. Most of the workshops focused on solving HOTS questions, designing learning plans, referring to current policies, "Independent Curriculum", and differentiated learning.

In addition, the duration of the TPD program is insufficient and participants do not feel the benefits of the program. There are workshops for teachers, but two days is not enough for us to master all the material; Follow-up programs such as coaching are needed to ensure proper implementation in the classroom so that we can feel the impact of the program. Learn more about the participants adding that "PD activities in teacher forums that everyone knows about only discuss how to solve HOTS questions. If the topic is lesson plan design, the correctness of our design results is never discussed. There is a lack of coaching, if only teaching without training and coaching is not optimal . With coaching, consultation regarding any problems, and the instructor can provide guidance, then teaching can continue. This shows that knowledge of 4C skills and strategies for their application must be included in ongoing PD programs for teachers. Facilities to support the integration of 4C skills in mathematics classes is still limited. This includes classroom equipment (electrical cables and projectors), reading materials, and teaching tools. According to six teachers, these materials are scarce in their schools. Facilities assistance from the government, but the equipment is damaged, and we cannot use it and there is no space classes that lack projectors or have faulty installations, we have to write manually on the blackboard or use manual teaching tools, which most students find uninteresting. The lack of facilities prevents teachers from integrating 4C skills in mathematics classes.

Fifth finding, political challenges. The final theme of our data analysis is political challenges, consisting of six categories: demand, funding, policy implementation, curriculum, university management, and monitoring and evaluation. Two participants mentioned explicitly that the mathematics teacher education program at their university did not require them to teach the 4C skills. The curriculum in mathematics education programs does not require lecturers to teach 4C skills. So far, perhaps because of my limited curriculum knowledge, there is no instruction on teaching 4C skills in our curriculum. To date, we have focused on teaching procedures. However, a review of the curriculum and lesson plans for each teacher education institution shows that the existing curriculum already covers many 21st century competencies. However, the challenge lies in implementing this curriculum systematically by aligning it with appropriate pedagogy, assessment and professional development programs. , and monitoring and

evaluation. Those who stated that the curriculum required them to teach 4C skills in their courses acknowledged that there were no specific university regulations regarding teaching 4C skills. Teachers are obliged to provide learning that develops students' 4C skills at school. In contrast, there are no regulations requiring teacher educators to train student teachers to acquire skills in higher education. As lecturers, we often hear about NCTM and educational foundations. However, there are no regulations requiring this, and workshops on 4C skills and HOTS-based teaching are less common in higher education than in primary and secondary schools. This problem is similar to the statement [TE04] that there must be regulations first, then they will be socialized to faculties and departments. So far it is only a lecturer's initiative. Educators have not prepared a curriculum to teach 4C skills. At least a teaching and learning strategies course should devote one chapter to this topic. On the other hand, in other words, lecturers and the curriculum at universities are not ready, only a few lecturers are willing to do it, but not explicitly, even students are not aware that it is a 4C skill.

Government readiness in terms of curriculum. There is a demand for democratic teaching and character development, but the competency development of teachers or teacher educators available now and in the future is still limited. Additionally, teacher teaching evaluations are based on something other than the 4C skills, even though the curriculum requires daily application. This condition shows that even though there is a government appeal to teach 4C skills, the implementation of this system is not yet available in several universities. This condition can be caused by a lack of understanding or awareness of the importance of these skills or competing priorities, budget constraints that limit the availability of funds, and teacher training programs that may not prepare prospective teachers in this field. Interpreting this theme, it is necessary to look again at policies that reflect the curriculum, emphasizing skills development more explicitly by providing systemic regulations to ensure daily implementation. This is a very complex process and requires in-depth discussions between stakeholders in the education sector to reach consensus, followed by intensive capacity building in its implementation. Compared to teacher education units, the political obstacles experienced by school teachers are quite different. In Indonesia, the 4C skills integration policy at school level has been well established.

Curriculum, teacher guidelines, and assessment systems are provided to help teachers implement policies. This policy was issued at the beginning of the 21st century teaching and learning framework and has been updated following current educational developments. At university level, this is not yet well established. However, the implementation process at the school level is not adequately monitored by authorities to determine whether teachers are using it. All participants demonstrated their understanding that 4C skills are mandatory in the mathematics curriculum, where they are expected to be able to develop their students' 4C skills. Following these guidelines, they seek to implement these policies in response to these demands. Their teaching process is monitored, but neither the principal nor supervisors from the regional education board specifically supervise their teaching of 4C skills. This is just a routine check. There is school and district supervision, but they do not specifically monitor the implementation of 4C skills teaching." The same thing was also reported by [ST10] "To my knowledge, supervision procedures over the last five years have not emphasized 4C skills. They review lesson plans, observe our learning, and provide feedback, and that's it." These findings reveal that teachers in universities and schools face similar challenges in equipping students with the 4C skills,

Discussion

This research produces an understanding of the challenges teacher education institutions face in preparing prospective mathematics teachers who know how to teach the 4C skills. The results of interviews with teachers revealed that prospective mathematics teachers must first acquire the 4C skills to teach these skills in mathematics classes. However, some teachers are concerned about the incompetence and lack of motivation of graduate mathematics teachers from universities. It is believed that pre-service mathematics teachers with limited basic mathematics knowledge require assistance to develop their 4C skills, which hinders their ability to teach 4C skills. Seeing the limited ability in mathematics and lack of motivation in learning creates other problems in pre-service. Teachers who must teach mathematics content use appropriate pedagogical approaches, learning activities, ICT equipment, and appropriate assessment tools to develop their students' 4C skills in everyday mathematics classes. Teachers who teach using 4C must prepare themselves with the help of ICT (Li et al., 2022;Tang et al., 2020;Baas et al., 2022).

Given educators' lack of competency and conceptual understanding of 4C skills, teacher education institutions should support them with mentorship, workshops, research grants, and facilities to develop the skills necessary to deliver mathematics courses based on 4C skills. It is important to support and encourage their professionalism, continue to invest in them, and reward them for creating innovative teaching. To some extent, prospective mathematics teachers may imitate the teaching practices of their

teachers, as they often view these teachers as practical and successful role models. It is believed that the behaviors and practices demonstrated by teacher educators in the classroom can significantly influence the teaching practices of their student teachers. For example, if teachers are innovative in engaging students' critical thinking, creativity, communication, and collaboration during lectures, then their teacher candidates will be more likely to model this knowledge in their teaching. Likewise, if educators demonstrate an inclusive and respectful learning environment, their teachers will be more likely to implement these values in their classrooms. In short, preservice teachers bring their unique experiences, perspectives, and knowledge to the mathematics classroom, influenced by their educators' teaching styles and approaches. Therefore, the capacity of teacher educators in designing innovative learning based on 4C skills must be increased. This research suggests using lesson study to improve platforms as an approach to increase their professionalism. School-university partnerships are one potential learning platform that can support prospective mathematics teachers from universities and in-service teachers from schools in gaining knowledge to teach 4C skills.

This finding is strengthened by previous research findings stating that this TPD model allows collaboration between prospective teachers, in-service teachers, and teacher educators to practice learning in schools and universities within existing structures, which is very important for designing innovative strategies for teaching 4C skills using expertise of university professors, school teachers, and teachers. researchers to bridge theory and practice (Chandra et al., 2020; Pedregosa et al., 2020; Soares et al., 2021; Tang et al., 2020). Lesson study in school-university partnerships is a powerful teacher training program for both prospective and existing teachers, with collaboration as an important component in the learning process to encourage improvement, especially changes in teaching and learning mathematics in the classroom in the 21st century. Linked to pedagogical challenges, lack of support and facilities, and political challenges, this requires a policy review. Content, pedagogy, assessment, facilities, professional development activities, and programs and their quality control must be prepared systematically for the implementation of a curriculum centered on 4C skills. Adjustments in funding, governance practices, and technological advances are also needed for implementation in teacher training institutions. An effective change strategy requires educational institutions to continually discover new possibilities and directions to improve the teaching and learning of 4C skills in the classroom. They should provide opportunities for prospective mathematics teachers to actively develop teaching skills to meet the teaching and learning needs of students in the twenty-first century. Otherwise, educational reforms carried out by the government or universities will only be superficial and counterproductive. This research means that this research provides an overview for prospective teachers and teachers to use 4C in learning with the help of ICT. Teachers in schools and prospective teachers in universities are starting to apply the 4C model to the students they teach using an assessment approach using ICT. Teachers and prospective teachers in higher education are trying to develop learning tools with the material they will teach to students. This research has implications for the development of teacher pedagogical progress in teaching in schools.

It is recommended that there are two potential ways to avoid or reduce this problem. First, the starting point is the registration process, where teacher education institutions ensure that students taking teacher training have a strong foundation in mathematical concepts, a high level of literacy and numeracy, a willingness to continue learning, and a passion for teaching. They must regulate admissions to teacher education to balance teacher demand and supply. Teachers who are passionate about their profession acquire advanced subject knowledge and implement advanced pedagogical teaching and learning practices. If these requirements are not met, teacher education institutions will produce unqualified mathematics teachers, thus having a negative impact on the academic achievement of Indonesian students. Moreover, this chain of underperformance seems difficult to break. Second, it is necessary to provide supporting programs such as workshops, academic attachments, learning communities, and school visits. Innovative teacher educators must view their students as assets and learning experiences must be designed based on each student's unique strengths and ability levels. This can help them create a more dynamic and inclusive learning environment where all students feel empowered to contribute and collaborate, resulting in increased student motivation and a deeper understanding of the course material. It is hoped that student abilities will no longer be the cause of educational failure in Indonesia. However, to meet growing challenges, teacher educators need new preparation—preparation that allows them to do more than cover curriculum and instruction but also instill a passion for learning in students. A new learning system is needed to encourage prospective mathematics teachers to become lifelong learners, creative, connected, and collaborative in solving problems, especially in developing their knowledge and skills to teach 4C skills.

4. CONCLUSION

This research concludes that it often happens that teacher education institutions prepare prospective mathematics instructors to teach 4C skills. Similar problems also occur in schools where mathematics teachers have difficulty improving students' 4C skills. This study identified student ability and instructor capacity as two significant challenges faced by teacher educators at the university level. Meanwhile, at the school level, students' practical abilities and challenges seem to be the main obstacles. Much effort is needed at the tertiary level to equip mathematics teachers with the knowledge and skills necessary to teach the 4C skills. Teacher training institutions must adopt a dynamic approach to equip graduates with the necessary tools, such as managing the enrollment, learning, and graduation processes. This should provide opportunities for prospective teachers to acquire the 4C skills to meet the current demand for mathematics teachers in the twenty-first century. It is also important to focus on the 4C skills of teacher educators and rethink how universities can evaluate and train them. Universities should consider the challenges school teachers face in integrating the 4Cs skills in mathematics in designing teaching and learning programs to better prepare future mathematics teachers. As teacher producing institutions, universities are responsible for providing mathematics education programs that are relevant and aligned with international school requirements. Providing mathematics teacher education programs with effective systemic policies and support programs, as suggested in the recommendations, brings us one step closer to filling the void currently experienced by frustrated educational practitioners and policymakers.

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