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Inclusive Mathematics Education in University Teacher Training: A Thematic Analysis of Reflections From an Innovative Educational Module*

Abstract. This qualitative study examined how Slovak pre-service mathematics teachers (PMTs) and university lecturers reflected on their participation in the Inclusive Mathematics Education (IME) module and how it shaped PMTs' professional identity and understanding of inclu-sion. Written reflections from 27 PMTs and four lecturers were analysed thematically (Braun and Clarke, 2006). Three themes emerged: (1) stereotypes and concerns about inclusion, (2) new insights into the holistic teacher role and individualization of teaching, and (3) shifts from theory-based to flexible, student-centred approaches. The study contributes to research on mathematics teacher education by showing how a structured university module can sup-port the development of a more holistic and inclusive professional identity among future mathematics teachers. The study highlights the importance of integrating experiential and reflective IME modules into teacher education to prepare PMTs for diverse classrooms.

1. Introduction

In the context of ongoing Slovak education reforms, applying inclusive principles to specific subjects such as mathematics has become crucial. As a signatory of the UN Convention on the Rights of Persons with Disabilities (2006), Slovakia is obliged to ensure equal access to quality education for all learners. In line with this commitment, the 2023 amendment to Act No. 245/2008 Coll. (the Education Act) introduced a formal definition and conditions for inclusive education.

Scherer and Bertram (2024) note that definitions of students requiring support differ across countries due to variations in legislation. The recent amendment to

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Slovak law (Act No. 245/2008 Coll.) broadened eligibility for support beyond the previous three categories — medical diagnoses, giftedness, and social disadvantage. Now, any student whose characteristics (e.g., health, background, language, cognition, motivation, or creativity) require assistance is entitled to appropriate measures, extending support to a much wider group.

Mathematics is still often seen as an exact, context-independent subject, which can hinder equitable access. However, Menon and Chang (2021) highlight the impact of cognitive, affective, motivational, and sociocultural factors on mathematical learning. This underscores the need for teachers to develop competencies for individualized and inclusive approaches (Roos, 2019; Faragher, Hill and Clarke, 2016; Rouse, 2008; Tan and Kastberg, 2017). Preparing future mathematics teachers for such practice requires systematic attention at the university level to address the broader dimensions of learning.

As Scherer and Bertram (2024) observe, many countries continue to maintain separate teacher education programs for special and general/inclusive education. These two traditions are grounded in different paradigms of teaching and learning and do not share a common understanding of inclusion. Special education typically focuses on learners with special educational needs (SEN), while inclusive pedagogy addresses the needs of all students, not only those with SEN. Armstrong et al. (2011) argue that this division stems from the assumption of separate educational approaches for different categories of children. Within the inclusive context, a central challenge lies in defining what inclusive mathematics education means, how its dimensions can be addressed, and how discrimination and marginalization in mathematics classrooms can be reduced. In this regard, Büscher and Prediger (2024) stress that teachers should integrate two complementary aspects into mathematics instruction: creating shared learning experiences for all students while simultaneously providing targeted, individualized learning opportunities.

In light of societal changes, advances in neuroscience, and the growing focus on inclusion, innovating university preparation for future mathematics teachers has become essential. This need is addressed specifically by Burton and Pace (2009), Scherer and Bertram (2024), and Egara and Mosia (2025), and more broadly within pre-service teacher education by Peebles and Mendaglio (2014). Abdulah and Mahmud's (2025) qualitative study further informs the design of teacher education and professional development programs aimed at equipping teachers with the competencies needed for inclusive mathematics instruction.

Therefore, targeted preparation of pre-service mathematics teachers (PMTs) for inclusive education is essential for their future professional practice. The persistent perception of mathematics as a purely exact and content-driven discipline often leads teachers to prioritise subject matter knowledge, while the holistic role of the teacher and the relational dimension of learning remain underemphasised. Yet, these dimensions constitute fundamental pillars of inclusive mathematics education and thus require systematic attention in PMTs education.

As professional identity develops continuously, an important question arises: to what extent and in what ways do PMTs reflect on inclusion, their emerging role as future teachers, and the enactment of inclusive principles in pedagogical practice? This area remains underexplored in our context. The present study

seeks to address this gap by focusing on three key analytical anchors: (1) the development of professional identity, (2) the holistic role of the teacher in inclusive mathematics education, and (3) the relational dimension of teaching.

2. Theoretical Framework

2.1. Inclusive Mathematics Education – Principles

The philosophy of inclusion has increasingly influenced education, including mathematics. According to UNESCO (2020), inclusive education requires all teachers to be prepared to teach every learner and to act as agents of change. Roos (2019) views inclusion in mathematics education at two levels: as a social ideology and as a set of practical solutions. Within this discourse, equal access to learning opportunities and equity are central principles.

Building on this, Abtahi and Planas (2024) distinguish two orientations, resisting marginalization and promoting equity, diversity, and inclusion, proposing a framework linking awareness of inclusive practices with their implementation. They identify three research directions: broadening curricula to reflect diversity, improving engagement strategies, and exposing biases in teaching and teacher education. Booth and Ainscow (2019) similarly stress the link between schools' inclusive values and everyday practices.

Despite growing attention to Equity, Diversity, and Inclusion (EDI), evidence-based approaches to reducing marginalization in mathematics remain scarce and require reflection on both ideological and practical levels (Abtahi and Planas, 2024). Gaffney and Faragher (2010) highlight the importance of effective teaching and strong leadership, while Tan and Kastberg (2017) and Florian (2017) call for a shift from deficit views of students toward addressing barriers created by instructional practices and classroom environments.

The earlier concept of integration, which placed students with special educational needs (SEN) into unchanged systems, failed to address environmental barriers. Faragher et al. (2016) argue that strategies designed for specific learners can benefit all students. According to UNESCO (2020), inclusive education requires teachers to value each learner's experiences and potential while reflecting on their own biases (Florian and Spratt, 2013). Rouse (2008) stresses teachers' key role in fostering participation and reducing underachievement, supported by positive attitudes and professional development. Meaningful, engaging activities further promote individual growth and classroom cohesion (Habalová, 2019).

Research on participation in mathematics highlights the importance of enacted mathematical and relational knowing—teachers' combined mathematical and relational leadership—in supporting inclusion (Gardesten and Palmér, 2023). Effective teachers show pride in students' achievements and build positive classroom climates (McDonough and Clarke, 2003). Relational competence (DeSimone and Parmar, 2006), the receptive teacher approach (Vodičková, Mitašíková and Slavíčková, 2023), and affective support (Sakiz et al., 2012) all contribute to students' motivation and engagement in mathematics.

Gardesten and Palmér (2023) identify three interconnected dimensions of inclusive teaching, spatial, relational, and didactical. Inclusive mathematics in-

struction depends on their interplay, viewing inclusion as more than curricular adaptation. Team-based formats such as co-teaching can enhance participation but require coordination, shared values, and collaborative planning to effectively support all learners.

Similarly, Vodičková et al. (2023) identified five factors that support the participation of students facing disadvantage or difficulty in mathematics: recognizing students' internal resources, adopting a receptive teacher approach, providing accommodations, fostering school–family cooperation, and ensuring institutional support at the school level. DeSimone and Parmar (2006) further emphasize the role of additional personnel, such as special educators, assistants, counsellors, and psychologists, as essential resources for mathematics teachers in inclusive settings.

2.2. Preparing Future Mathematics Teachers for Inclusion

According to UNESCO (2020), preparing teachers for inclusive education requires professional training, support, favourable conditions, and autonomy to focus on each learner's success. Teacher education must challenge deficit-based beliefs about students. Abdulah and Mahmud (2025) stress that teachers need specific competencies developed during university training. The European Agency for Special Needs Education (2012) identified four core values in its Profile of Inclusive Teachers: valuing learner diversity, supporting all learners, collaboration, and professional development, reflecting the balance of knowing, doing, and believing (Rouse, 2006). Similarly, Kováčová and Hučková (2024) emphasize cultivating both knowledge and inclusive dispositions.

Abdulah and Mahmud (2025) further outline five key competencies for elementary mathematics teachers: content mastery, flexible strategies, technology use, classroom management, and assessment. Scherer and Bertram (2024) describe the German ProViel project, which integrates inclusive mathematics education into university programs through two courses: SLE (Learning Mathematics with Substantial Learning Environments), focusing on constructivist approaches and natural differentiation, and TLM (Teaching and Learning Mathematics), addressing research, inclusive education, and Universal Design for Learning (UDL).

Egara and Mosia (2025) highlight Culturally Responsive Teaching, UDL, and Differentiated Instruction as essential strategies for equitable mathematics education, while Hubbard and Livy (2021) underscore the role of external consultants in supporting differentiated planning. Peebles and Mendaglio (2014) note that although inclusion-focused training improves attitudes and theoretical understanding, limited hands-on experience with students with SEN reduces readiness. Thus, practical, reflective experiences during pre-service education are crucial for developing effective inclusive mathematics teachers (Egara and Mosia, 2025; Scherer and Bertram, 2024).

Peebles and Mendaglio (2014) also describe the Individual Direct Experience Approach (IDEA), in which pre-service teachers work individually with a student with SEN during practice. IDEA enables teachers to experience direct interactions, apply acquired knowledge and skills, and adapt lessons for the whole class based on these interactions.

2.3. Specialized Thematic Educational Module: "Inclusive Mathematics Education"

At the Faculty the research was conducted, the undergraduate preparation of PMTs continuously integrates insights from inclusive mathematics education. PMTs also undertake their first field experiences in mainstream schools, gaining initial exposure to teaching students with SEN. These efforts are reflected in the ongoing innovation of the university course Didactics of Mathematics, which includes a specialized thematic module entitled Inclusive Mathematics Education (IME). Offered to multiple cohorts since 2020, the IME module aims to develop students' understanding of diversity, foster inclusive attitudes, and enhance readiness to apply inclusive principles in real educational settings.

The module is structured around several components:

1. **Theoretical foundations:** The module draws on developmental and learning theories, including neuroscience, to explain the biological and cognitive bases of learning. Students explore the bio-psycho-social model of disability, Bronfenbrenner's ecological systems theory (Bronfenbrenner and Ceci, 1994), the social model of disability (Tan and Kastberg, 2017), and the Inclusive Teacher Profile (adapted from the European Agency for Development in Special Needs Education, 2012). Topics also include school support mechanisms, multilevel barriers to inclusion, relational and receptive pedagogical approaches, and inclusive communication in mathematics education.

2. **Mapping knowledge and attitudes:** An initial assessment of PMTs' existing knowledge and attitudes regarding diversity and inclusion.

3. **Experiential learning activities:** The first activity simulates how adverse conditions, such as restricted movement, impaired vision, limited writing ability, or environmental distractions, can affect students' ability to solve a mathematics task. A second hands-on activity illustrates the potential negative impact of a non-supportive teacher who focuses solely on curriculum content while neglecting students (in our case PMTs) emotional experiences.

4. **Presentation of learners' challenges:** PMTs are introduced to a wide range of challenges, including neurodevelopmental and functional disorders, disabilities, and broader life-context factors (e.g., divorce, trauma, vulnerable caregivers, social disadvantage, migration, bilingualism). The module also compares earlier narrow definitions of SEN with broader contemporary ones. Students share their own practical experiences teaching students with SEN or other disadvantages.

5. **Teacher typologies:** Various teacher types are presented to illustrate differences in personality traits and professional roles.

6. **Planning mathematics tasks in inclusive contexts:** PMTs practice designing tasks using principles of differentiated instruction and Universal Design for Learning.

Through these components, the IME module equips PMTs with tools to critically reflect on their teaching practices and develop inclusive strategies that address the diverse needs of learners in mathematics classrooms.

3. Research Methodology

3.1. Research Design

A qualitative research approach was employed to explore how PMTs and participating university teachers reflect on their engagement in the specialized module IME. This methodology is particularly suited for in-depth exploration of experiences and meanings, rather than hypothesis testing.

The main research question was: *How do PMTs and participating university educators reflect on the contribution of the specialized IME module to the development of PMTs' professional identity and teaching practice?*

3.2. Research Sample and Data Collection Methods

The participants comprised 27 PMTs (coded as "S") and four university lecturers, from who two acted as participating observers (coded as "PO"), and two as non-participating observers. PMTs were in their first year of study and had completed compulsory teaching placements in secondary schools. Several had prior part-time teaching experience. University lecturers either co-taught or observed the IME module. Labels "S" and "PO" are used in the results without further specification of individual participants. Data were collected between september 2022 and september 2025 through anonymous written reflections from both students and participating observers after completing the IME module. Students submitted reflections either during class or electronically via Microsoft Forms. Data collection was as follows:

- Academic year 2022–2023: fourteen PMTs submitted reflections, with 11 provided on paper and 3 via Forms; all four observers submitted their reflections electronically
- Academic year 2024–2025: 13 PMTs reflections submitted via Forms

All reflections were anonymized and transcribed into Microsoft Word for analysis.

To guide participants' reflections and ensure a degree of consistency across cohorts, a set of open-ended prompts was used. These prompts were designed to encourage reflection on both personal learning and emerging professional perspectives. Participants were asked, for example: How did the IME module influence your understanding of inclusive mathematics education? What changes, if any, did you experience in your perception of students and diversity in mathematics classrooms? How do you reflect on your role as a future mathematics teacher in inclusive settings? What challenges and opportunities do you perceive in implementing inclusive principles in mathematics teaching? Which situations or activities from the module most influenced your thinking or future teaching practice?

These open-ended prompts ensured that reflections addressed shared thematic areas while still allowing participants sufficient freedom to express their individual experiences and meanings.

3.3. Analysis of research data

The transcribed narratives were subjected to thematic analysis following Braun and Clarke (2006). This method allows identification and interpretation of patterns of meaning (themes) in qualitative data and is appropriate for exploring participants' subjective experiences and perceptions.

The analysis followed the six-step procedure as described in Braun and Clarke (2006):

1. Familiarization with the data
2. Generation of initial codes
3. Searching for themes
4. Reviewing themes
5. Defining and naming themes
6. Producing the analytical report

The analysis combined semantic-level coding (explicit meanings) with latent-level interpretation (underlying assumptions and frameworks). This approach captured both surface and deeper meanings in the data. The process was iterative and reflexive, with continuous documentation and reflection on coding decisions. Identified themes were supported by representative statements and explicitly linked to the research question.

3.4. Ethics

This research was conducted as part of a project guided by a Data Management Plan approved by the university's ethical committee. All personal data were collected, stored, analysed, and used anonymously. Participants were fully informed about the intended use of the information and gave active, written consent for data collection for scientific purposes. An Informed Consent Form was provided to every participant involved in activities that might generate data later used in publications or project outputs.

4. Results

Thematic analysis of reflections from PMTs and university educators after completing the specialized module IME revealed three overarching themes and seven sub-themes. These are summarized in Table 1.

Table 1: Overview of Themes and Sub-Themes

Theme	Sub-Themes
1. Stereotypes and concerns	1.1 Polarized distribution of students in the teaching group 1.2 Subjective generalized labelling of students 1.3 Perception of mathematics as a rigorous subject 1.4 Concerns about implementing inclusive principles – discrepancy between theory and practice
2. Newly acquired knowledge	2.1 Knowledge about factors negatively affecting inclusive teaching 2.2 Deeper understanding of the teacher's role in inclusive mathematics education 2.3 Awareness of the need to individualize the teacher's approach to each student
3. Practical implications for inclusive teaching	3.1 Implementation of inclusive teaching practices in mathematics education

Theme 1: Stereotypes and Concerns

Participants' reflections revealed persistent stereotypes and concerns about implementing inclusive mathematics education.

Sub-theme 1.1: Polarized distribution of students in the teaching group

A prominent stereotype among PMTs was a dichotomous view of the classroom, dividing students into "neurotypical" students and students with special educational needs (SEN). Many reflections suggested limited awareness of the diversity within every classroom and of students experiencing difficulties outside diagnostic categories. Examples illustrating this "black and white" perception include:

- **S:** "A common negative phenomenon among students with cognitive impairments is a significant decline in motivation because they achieved below-average results."
- **S:** "Students with depressive disorders experienced a chronic decline in attention in class."
- **S:** "Students with language barriers were often frustrated and sometimes showed signs of despair because lessons were conducted in a language that was foreign to them, and they lacked continuity in the subject matter."
- **S:** "Even if the teacher were more skilled at working with students with

special educational needs, I don't think there is room in a regular school for them to fully engage these students."

- **S:** "I see the limitations of inclusion mainly in the fact that integrated students often draw attention to themselves (often unintentionally)."

These narratives reflect a tendency to generalize students into rigid categories, often positioning students with disabilities as separate from "normal" neurotypical peers. Examples of such narratives include:

- **S:** "By inclusion, I mean the integration of a heterogeneous element into a homogeneous whole. I don't just mean children with learning disabilities."
- **S:** "In inclusion, we put some other students together with normal students. It is a joint inclusion where some special students can function with others."
- **S:** "Inclusion is about integrating students with special needs among others."
- **S:** "For me, inclusion is like set theory – it integrates students who are different and can work together."

Conversely, some PMTs demonstrated a shift toward a more inclusive mindset:

- **S:** "I would like my classes to be for everyone, regardless of race, religion, sexual orientation, gender, mental disorders, etc."
- **S:** "I would like to be someone who accepts their students as they are and does not try to remake them in my own image."
- **PO:** "In mathematics, where the world is beautiful, clear, everything is true or false, or an unconfirmed hypothesis, but one can think about it and look for a solution, I realized more than from any other theory that teaching mathematics is not so black and white."

These reflections indicate that engagement with the IME module helped PMTs recognize initial stereotypes and begin adopting more inclusive perspectives toward classroom diversity.

Sub-theme 1.2: Subjective Generalized Labelling of Students

PMTs often associated students' problematic behaviour in mathematics with specific diagnoses or assumed disorders, reflecting a prevailing stereotype that behavioural challenges automatically indicate a disability. Participants noted that children without formal diagnostic "labels" may receive insufficient support, while disruptive behaviour was frequently attributed to inherent deficits rather than situational factors. Illustrative examples include:

- **S:** "He was always running around. He definitely has ADHD."
- **PO:** "I thought the student must have some kind of disorder and that it was a matter for a specialist; there's nothing I can do about it; after all, I'm just a math teacher."

- **S:** "I had one Ukrainian student in my class who just sat there. He didn't know Slovak, he didn't know English. I didn't know what to do with him."

Participation in the IME module helped PMTs recognize that behaviour often has multifaceted or temporary causes. Disruptive behaviour can result from internal or external stimuli, including teacher-student interactions, and is not necessarily a manifestation of long-term problems. For example:

- **S:** "After an intensive experiential activity, I became aware of external factors that made learning very difficult for me. For example, when I tried to write with plastic bags on my hands, or when I was hot, or when loud noises disturbed me. This insight also applies to my teaching, where I observe similar behaviour in students. Undisciplined behaviour may have deeper reasons, such as impatience or disruption to express frustration."
- **S:** "I try to really understand my students and the motivation behind their actions."
- **S:** "I want to explore the connection between cognitive development and brain function to better understand learning processes."

These reflections demonstrate that experiential activities within IME enabled PMTs to appreciate the complex causes of student behaviour and recognize the potential impact of their own teaching practices on classroom dynamics.

Sub-theme 1.3: Perception of Mathematics as a Rigorous Subject

Many participants initially viewed mathematics as a subject primarily defined by objective performance and measurable outcomes. This perception contributed to concerns that "weaker" students, including those with SEN, might slow down "stronger" students. Examples from participants include:

- **S:** "In an ideal world, I am in favour of inclusion, but in today's world, I am not, because it is also at the expense of the education of other students."
- **S:** "Inclusion can hinder the progress of those who are more intelligent in mathematics."
- **S:** "These children can negatively drag down other regular students."

Participants recognized mathematics as a discipline that demands precision, independent thinking, and attention to detail, where errors can have significant consequences. Traditional teaching practices often emphasize performance over student-centred learning.

However, reflections after the IME module revealed a shift toward a more holistic perspective, emphasizing both mathematical learning and students' well-being. PMTs highlighted the importance of cultivating qualities such as effort, resilience, curiosity, and enjoyment in learning:

- **S:** "My dream is to have happy and calm children who are ready to think. I want to believe in their abilities and appreciate their effort and courage."

- **S:** "I would like to use trial and error in math classes so that students can see that even mistakes can move us forward."

These reflections indicate that the IME module encouraged PMTs to balance the rigor of mathematics with attention to the individual needs and experiences of learners.

Sub-theme 1.4: Concerns About the Implementation of Inclusive Principles

Participants expressed concerns regarding the feasibility of inclusive mathematics education, highlighting a perceived gap between the ideal of inclusion and its practical implementation. Key concerns included insufficient financial, professional, and logistical support, as well as the high number of students in teaching groups. Examples include:

- **S:** "I think it's a very good idea, but I don't see it being realistic to implement in the near future."
- **S:** "Inclusion is important, but resources are needed. Without preparation, the inclusion of children with special educational needs will end badly."
- **S:** "The perception of each student in school is a problem. Teaching more than 100 children part-time, I see that inclusive teaching requires a lot of extra time, often at the expense of the teacher's family."
- **S:** "How can I be fully inclusive with so many pupils?"

These reflections illustrate that PMTs recognize inclusion as a desirable but challenging goal. The IME module helped them reflect critically on practical barriers and the need for structural and institutional support to implement inclusive principles effectively.

From the perspective of the theoretical framework, these findings reflect an early stage in the development of professional identity. PMTs' reflections reveal a tendency to rely on simplified and often dichotomous conceptions of learners, accompanied by a predominantly performance-oriented view of mathematics teaching. Such perspectives indicate a limited integration of the holistic teacher role, particularly in relation to the relational and socio-emotional dimensions emphasised in inclusive education.

Theme 2: Newly Acquired Knowledge

Through participation in the IME module, PMTs reported three main areas of newly acquired knowledge, which we discuss below.

Sub-theme 2.1: Insights on Factors Negatively Affecting Inclusive Teaching

PMTs gained a deeper understanding of the internal and external factors that can hinder inclusive mathematics teaching. Internal factors included students'

unmet physiological needs (e.g., hunger, fatigue), functional limitations critical to learning, and temporary conditions such as anxiety, post-illness recovery, or immaturity of the nervous system. Participants also explored the impact of diagnosed conditions, including ADHD, ASD, learning disabilities, and FASD.

External factors included physical classroom conditions (noise, lighting, space) as well as social-ecological influences from family, classroom, school, and community contexts. PMTs reflected on their own experiences in the IME module, particularly during experiential activities that simulated adverse conditions, as illustrated below:

- **S:** "I remember that for me, math was associated with stress, fear, and nervousness, and that often caused me to lose focus in class."
- **S:** "I realized that I need to pay more attention to what is going on around me."
- **S:** "Negative comments from teachers are harmful; various elements of the environment can affect a student's learning."
- **S:** "I see this as the greatest benefit of this educational module. We tried simulated conditions of reduced sensitivity and worked with assistive software for the blind."

These narratives show that PMTs developed an awareness of the multifaceted nature of obstacles to learning and the importance of addressing both internal and external factors.

Sub-theme 2.2: Deeper Understanding of the Role of Teachers in Inclusive Mathematics Education

PMTs reflected on the holistic development of mathematics teachers as presented in our ABCD model introduced during the IME module. This model has overlap with Shulman's PCK model (1987). According to this model, inclusive mathematics teachers must develop expertise across four dimensions:

A. Mathematics content knowledge

B. Mathematics didactics

C. Bio-psycho-social understanding of child development

D. Personal and professional growth

The following narratives illustrate PMTs' reflections on these dimensions:

- **S:** "I would like to be a teacher who understands what they are doing and what they are teaching."
- **S:** "I want to accept my students as they are and not try to change them to suit myself."
- **S:** "I aim to influence and guide my students in the most positive way possible."

- **S:** "I would like to be understanding, approachable, professional, but human."
- **PO:** "I have to be very careful about my nonverbal communication, even today."

Conversely, some PMTs initially limited themselves to the A and B dimensions, perceiving themselves primarily as mathematics experts and relying heavily on support staff (assistants, specialists, special educators) for inclusive practices. Other PMTs acknowledged the challenges of inclusion and reflected on their own limitations:

- **S:** "Inclusion is good, but there are many problems and obstacles, and certain conditions must be met."
- **S:** "A teacher can't be everything; it's a big burden, and our education system isn't prepared for it."

Personal experiences as students also shaped participants' understanding of inclusion:

- **S:** "I had a strict teacher; all those bad feelings came back when I thought about teaching."
- **S:** "I had classmates with autism or recovering from stroke; seeing their experiences taught me the importance of support and understanding."
- **S:** "As a teacher, I want mathematics not to be a source of fear for my students, as it was for me in college."

These reflections demonstrate that the IME module encouraged PMTs to develop both self-awareness and professional identity as inclusive educators.

Rather than viewing inclusive teaching as an external addition to mathematics instruction, participants increasingly reflected on it as an integral part of what it means to become a mathematics teacher. In this sense, the ABCD model functioned not only as a conceptual framework but also as a lens through which PMTs began to reconstruct their emerging professional identity.

Sub-theme 2.3: Awareness of the Need to Tailor Teaching to Individual Students

PMTs recognized the importance of individualizing instruction and supporting students according to their specific needs, consistent with Halinen and Järvinen (2008), who emphasize that no student should be left without teacher support. Participants highlighted the value of fostering curiosity, engagement, and student-centred learning:

- **S:** "I want my students to be driven by a sense of discovery and a positive feeling from solving problems."
- **S:** "I want students to understand that the journey is as important as the destination."

- **S:** "It's a kind of facilitation and reinforcement for students."

PMTs also reflected on practical adjustments in teaching for students with specific needs:

- **S:** "In a class with a student who has a hearing impairment, I had to turn around so the student could read my lips during lessons."
- **S:** "Some students had assistants who helped them follow the lessons; I had to coordinate with them to ensure full participation."
- **PO:** "We had students with different difficulties, but we tried anyway, and those students successfully completed school."

They emphasized the importance of systemic support and teamwork:

- **S:** "Thanks to grants, schools have strong support teams for inclusive education."
- **S:** "Support staff help not just individual students but the whole class, enabling inclusive practices to succeed."

These reflections indicate that PMTs recognized the necessity of tailoring teaching approaches, both individually and collectively, to promote inclusive mathematics learning.

The identified shifts in participants' reflections suggest not only the acquisition of new knowledge, but also a gradual transformation of professional identity. PMTs began to integrate cognitive, relational, and socio-cultural dimensions of teaching, moving towards a more holistic understanding of the teacher's role. This development aligns with the conceptualisation of the teacher as a multidimensional professional, as reflected in the ABCD model introduced in this study.

Theme 3: Practical Implications for Implementing Inclusive Teaching Practices

Participation in the IME module had both immediate and longer-term implications for PMTs' teaching practices. PMTs reflected on how the module influenced their approaches to teaching mathematics in inclusive classrooms. They reported adjustments in instructional strategies, classroom management, and lesson planning, highlighting a growing awareness of students' emotional and cognitive needs.

PMTs described specific changes in their teaching:

- **S:** "I realized that in math classes, it is enough to reduce pressure on performance, and the student will calm down."
- **S:** "I thought that my students might be under a lot of stress in math class, so I considered what I could change or do differently in future lessons."
- **S:** "As part of my lesson preparation, I include modifications to exercises to teach in a differentiated or individualized way."
- **S:** "I consider what would help students with difficulties in math, for example, what software tools to use to support students with weaker motor skills."

Some PMTs reported longer-term changes in their educational trajectory as a result of the module:

- **S:** "After completing this educational module, I added additional courses related to special education and psychology in my study programme for the following semester. My goal was to better understand children with difficulties."

The influence of the IME module was also evident in the reflections of participating observers, who noted that PMTs demonstrated increased sensitivity and intentionality in their teaching practice:

- **PO:** "After completing the module on inclusive mathematics education, I observed in students' exercise diaries how sensitively they perceived teachers' actions and responses during mathematics lessons."
- **PO:** "When preparing for practical lessons in the following semester, students incorporated the knowledge they had gained from this module into their lesson plans and teaching approaches."

These narratives indicate that the IME module not only enhanced PMTs' awareness of inclusive principles but also translated into tangible actions in classroom practice. PMTs became more attentive to students' diverse needs, more flexible in lesson design, and more reflective about their own professional development as inclusive mathematics educators.

The reported changes in teaching approaches indicate that these shifts were not limited to declarative knowledge but began to translate into envisioned and enacted practice. PMTs described concrete adaptations in instruction, communication, and lesson planning, suggesting an emerging sense of pedagogical agency. This development reflects a transition from a primarily content-oriented identity towards a more holistic and relational conception of the mathematics teacher, consistent with inclusive education principles.

5. Discussion

The findings are discussed through the lens of professional identity development and holistic conceptions of teaching, which served as the main theoretical anchors for the analysis.

Theme 1: Stereotypes and Concerns

Sub-theme 1.1: Polarized Division of Students in the Teaching Group

Within this stereotype, PMTs frequently expressed the belief that mathematics students can be dichotomously divided into "typical" students and students with special educational needs (SEN). Such polarized thinking indicates a prevailing segregation narrative that contradicts the broader inclusive education principles outlined in Article 24 of the CRPD (2016), which emphasizes the elimination of discrimination and equal access to education for all. Participants' reflections

aligned more with a narrower conceptualization of inclusion, focused on integrating specific groups of students, particularly those with disabilities or SEN, into mainstream classrooms (Ainscow et al., 2006; Armstrong, Armstrong and Spandagou, 2011).

Our findings echo Pais (2014), who highlighted ongoing discriminatory tendencies in education, where certain school practices maintain exclusivity and mathematics is perceived as accessible only to a select group of students. Many PMTs in our study appeared unaware that mathematics learning is a neurodevelopmental process and that difficulties in mathematics do not automatically indicate SEN. This aligns with Demo et al. (2021), who note that students often struggle to connect semiotic representations with the underlying mathematical objects, and with Vygotsky's theory, which emphasizes the developmental transition from concrete to abstract internalized thinking. Nieminen, Reinholz, and Valero (2024) describe how "ideal" mathematics students are viewed as fast, individualistic, and measurable, while "disadvantaged" students are seen as slow, emotional, and elusive. Our research underscores the importance of addressing such segregationally attitudes early in undergraduate teacher training.

Sub-theme 1.2: Subjective Generalized Labelling of Students

Participants often perceived students who displayed challenging behaviour as either undisciplined or automatically assumed to have a disorder. This tendency for subjective labelling reflects a professional bias that can hinder inclusive mathematics teaching. Nieminen, Reinholz, and Valero (2024) demonstrate how assessment and teaching practices may normalize certain student behaviours, framing disadvantaged students as "abnormal." UNESCO (2020) emphasizes the need for teacher training to challenge entrenched beliefs that some students are inherently incapable of learning.

Our findings also resonate with Moreira and Manrique (2014), who mapped mathematics teachers' attitudes toward inclusion, revealing a continuum from highly accepting and adaptive to resistant and biased. Abtahi and Planas (2024) highlight the necessity of uncovering and transforming discriminatory practices, emphasizing reflective re-evaluation of traditional teaching ideologies. Incorporating frameworks such as Perry (2006) and Bronfenbrenner and Ceci (1994) can help PMTs appreciate students' wider social and developmental contexts. Scherer and Bertram (2024) found that master's-level teacher education programs can effectively challenge stereotypical beliefs about innate mathematical ability, demonstrating the value of targeted inclusive mathematics training.

Sub-theme 1.3: Perception of Mathematics as a Rigorous Subject

Participants frequently emphasized performance and measurable outcomes in mathematics over students' individual needs. Pressure from curricula, parents, and supervisors often outweighed consideration of students' holistic learning experiences. This finding aligns with Florian and Spratt (2013), who argue that every student is entitled to varied educational opportunities, and with Nieminen et al. (2024), who note that mathematics' evaluative focus accentuates ability-based dis-

tinctions. Gardesten and Palmér (2023) further stress that inclusive mathematics education requires balancing professional and relational guidance, ensuring students feel supported and engaged.

Sub-theme 1.4: Concerns About the Implementation of Inclusive Principles

PMTs expressed concerns about the feasibility of inclusive teaching, highlighting gaps in financial, conceptual, and professional support. Forlin (2001) identifies teachers' lack of skills and attitudes as significant barriers to inclusion. DeSimone and Parmar (2006) similarly report that even supportive teachers often feel unclear about their responsibilities toward included students. Our findings indicate that PMTs perceive practical barriers (class size, inadequate resources, and limited institutional preparedness) as obstacles to implementing inclusive mathematics education effectively.

Theme 2: Newly Acquired Knowledge

Sub-theme 2.1: Knowledge About Factors Negatively Affecting Inclusive Teaching

PMTs gained insights into internal and external factors influencing inclusive mathematics learning. Internal factors included physiological needs, temporary conditions, or functional limitations, while external factors involved classroom environment and broader social-ecological influences (Demo et al., 2021; Florian, 2017). Experiential activities in the IME module allowed PMTs to directly experience how these factors impact learning, reinforcing awareness of diverse student needs.

Sub-theme 2.2: Deeper Understanding of the Teacher's Role

Participants reflected on the ABCD model of teacher development: combining expertise in mathematics, mathematics didactics, bio-psycho-social understanding of child development, and personal development. This holistic view aligns with Burton and Pace (2009), who emphasize the need for teachers to move beyond formal knowledge of diagnoses and SEN, and with Vodičková, Mitašíková and Slavíčková (2023), who highlight teacher sensitivity to student diversity as essential for inclusive mathematics education. Gardesten and Palmér (2023) further stress the importance of integrating professional and relational knowledge to achieve full inclusion. Our findings revealed tension: while PMTs recognized the need for relational awareness, they often felt unprepared to manage diverse classroom needs.

Sub-theme 2.3: Recognizing the Need to Tailor the Teacher's Approach to Individual Students

Participants became aware of the importance of attending to individual students' characteristics and ecosystemic contexts to avoid generalist categorization and to support personalized learning (Gardesten and Palmér, 2023). This shift

from seeing the teacher as a content deliverer to an active facilitator of learning reflects the development of inclusive teacher identity. Sakiz, Pape, and Woolfolk Hoy (2012) underscore the positive effects of affective teacher support on students' mathematics outcomes, a perspective mirrored in PMTs' reflections. Abtahi and Planas (2024) note that diversity is both a challenge and a catalyst for pedagogical adaptation, echoing our findings that PMTs began to view students' differences as resources for lesson planning rather than obstacles.

Theme 3: Practical Implications for Inclusive Teaching Practices

The IME module enabled PMTs to translate theoretical knowledge into classroom practice, consistent with Gardesten and Palmér's (2023) concept of "enacted knowing." Experiential activities encouraged PMTs to differentiate tasks, adapt communication, and reflect on student behaviour. Some PMTs incorporated culturally relevant frameworks, universal design principles, or differentiated instruction in their teaching, consistent with culturally responsive teaching approaches (Egara and Mosia, 2025). Scherer and Bertram (2024) reported similar improvements in self-efficacy and inclusive teaching confidence among master's-level teacher candidates.

Our study confirms the observations of Abtahi and Planas (2024) that awareness of inequality alone does not guarantee inclusive practice. PMTs require structured support to develop practical pedagogical agency, bridging the gap between inclusive ideals and classroom implementation. The IME module contributed to this development by providing opportunities for reflection, experiential learning, and the translation of inclusive principles into concrete teaching strategies.

6. Conclusion

This study highlights the importance of integrating both theoretical knowledge and practical experiences of inclusive teaching into undergraduate mathematics teacher education. Its aim is to ensure that PMTs feel professionally prepared to teach in inclusive classrooms. Our findings indicate gaps in theoretical understanding, inclusive attitudes, and practical teaching skills. In Slovakia, PMTs are legally required to teach inclusively, making it essential that undergraduate programs equip them to think and act inclusively in practice. As Rouse (2008) points out, it is unrealistic for teachers to rely on an "army of experts" to manage individual student needs; inclusive teaching must be feasible for generalist teachers as well.

Based on our findings and relevant literature, key components of teacher preparation for inclusive mathematics education should include:

- Philosophical, attitudinal, and value-based aspects of inclusion,
- Understanding the diversity of students in mainstream classrooms, including but not limited to students with special educational needs (SEN),
- Neuroscience-informed perspectives on learning, maturation, and mathematical performance,

- Theoretical frameworks such as the learning pyramid, Maslow's hierarchy of needs, Perry's neurosequential model, the iceberg theory, and Bronfenbrenner's bioecological model,
- Classifications and frameworks such as Classification of Diseases 11 (WHO, 2025) and International Classification of Functioning, Disability, and Health – children and youth version (WHO, 2007),
- Practical application of the ABCD model of teacher identity for developing inclusive teaching profiles,
- Identification of supporting factors and barriers in inclusive mathematics education,
- Experiential activities and practical exercises simulating inclusive classroom conditions (e.g., Peebles and Mendaglio, 2014, IDEA model),
- Modification and application of diverse teaching strategies, including Universal Design for Learning and Differentiated Instruction,
- Communication and psychosocial skill development for effective teacher-student interaction.

Our study demonstrates that a specialized thematic training module on IME effectively supports the development of both inclusive knowledge and pedagogical agency among PMTs. Participants in the module reported heightened awareness of student diversity, enhanced understanding of the factors affecting learning, and greater readiness to adapt teaching practices to meet individual student needs. This aligns with international evidence emphasizing that inclusive competence develops through the integration of theoretical understanding, relational awareness, and practical experience (Abtahi and Planas, 2024; Gardesten and Palmér, 2023; Florian, 2017).

We therefore recommend the introduction of a dedicated course on IME within undergraduate programs. Ideally, such a course should be delivered by a multidisciplinary team (including specialists in mathematics didactics, psychology, therapeutic pedagogy, and special education) to ensure a comprehensive approach. Implementing this curriculum would not only respond to the legal mandate for inclusive education in Slovakia but would also contribute to the preparation of future teachers who are reflective, flexible, and capable of translating inclusive ideals into effective classroom practice.

7. Limitation of the study

A limitation of this research was the relatively small number of participants: 27 PMTs and four university lecturers, including two participatory observers and two non-participatory ob-servers. Data were collected in written form, which limited opportunities for follow-up or elaboration on participants' reflections. Future research could benefit from in-depth, face-to-face interviews with both PMTs and university lecturers. Additionally, video recordings of the IME module could

provide richer insights by capturing real-time reflections and interac-tions during teaching, allowing for more nuanced analysis of participants' conceptual think-ing.

As is typical in qualitative research, the study focuses on mapping participants' subjective views, ideas, and experiences in inclusive mathematics education. Conducted as field research within Slovak mainstream primary and secondary schools, it offers a perspective grounded in actual practice. However, due to the limited sample size and the qualitative nature of the study, the findings cannot be generalized to all pre-service mathematics teachers or educa-tional contexts, this represents an inherent limitation of the approach. On the other hand, the study provides valuable, original insights from young PMTs, capturing their critical and open-minded perspectives on school reality, as well as their attitudes, stereotypes, and current un-derstanding of inclusive mathematics education.

References

Abdulah, N. N. and Mahmud, M. S. (2025). Teaching competencies of mathematics teachers in inclusive education at primary schools. *International Journal of Learning, Teaching and Educational Research*, **24**(1), pp. 190–208. https://doi.org/10.26803/ijlter.24.1.10

Abtahi, Y. and Planas, N. (2024). Mathematics teaching and teacher education against marginalisation, or towards equity, diversity and inclusion. *ZDM Mathematics Education*, **56**(3), pp. 307–318. https://doi.org/10.1007/s11858-024-01602-x

Act No. 245/2008 Coll. (2008). Act on Education (the Education Act) and on Amendments and Supplements to Certain Acts. Available at: https://www.slov-lex.sk/ezbierky/pravne-predpisy/SK/ZZ/2008/245/

Ainscow, M., Booth, T. and Dyson, A. (2006). *Improving Schools, Developing Inclusion*. London: Routledge. https://doi.org/10.4324/9780203967157

Armstrong, D., Armstrong, A. C. and Spandagou, I. (2011). Inclusion: By choice or by chance? *International Journal of Inclusive Education*, **15**(1), pp. 29–39. https://doi.org/10.1080/13603116.2010.496192

Booth, T. and Ainscow, M. (2019). *Index inklúzie*. Bratislava: Nadácia pre deti Slovenska.

Braun, V. and Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, **3**(2), pp. 77–101. https://doi.org/10.1191/1478088706qp063oa

Bronfenbrenner, U. and Ceci, S. J. (1994). Nature–nurture reconceptualized in developmental perspective: A bioecological model. *Psychological Review*, **101**(4), pp. 568–586. https://doi.org/10.1037/0033-295X.101.4.568

Burton, D. and Pace, D. (2009). Preparing pre-service teachers to teach mathematics in inclusive classrooms: A three-year case study. *School Science*

and Mathematics, **109**(2), pp. 108–115. https://doi.org/10.1111/j.1949-8594.2009.tb17943.x

Büscher, C. and Prediger, S. (2024). Teachers' practices of integrating challenging demands of inclusive mathematics education in a professional development program. *Journal of Mathematics Teacher Education*, **27**(2), pp. 209–233. https://doi.org/10.1007/s10857-022-09560-5

Demo, H., Garzetti, M., Santi, G. and Tarini, G. (2021). Learning mathematics in an inclusive and open environment: An interdisciplinary approach. *Education Sciences*, **11**(5), 199. https://doi.org/10.3390/educsci11050199

DeSimone, J. R. and Parmar, R. S. (2006). Issues and challenges for middle school mathematics teachers in inclusion classrooms. *School Science and Mathematics*, **106**(8), pp. 338–348. https://doi.org/10.1111/j.1949-8594.2006.tb17754.x

Egara, F. and Mosia, M. (2025). Equipping pre-service mathematics teachers for diverse classrooms: Best practices and innovations. In: B. E. Olawale, ed., *Building the Foundations: Effective Approaches in Mathematics Teacher Preparation*, pp. 138–152.

European Agency for Development in Special Needs Education (2012). *Profile of Inclusive Teachers*. Available at: https://www.european-agency.org/sites/default/files/profile_of_inclusive_teachers_sk.pdf

Faragher, R., Hill, J. and Clarke, B. (2016). Inclusive practices in mathematics education. In: K. Makar et al., eds., *Research in Mathematics Education in Australasia 2012–2015*, pp. 119–141.

Florian, L. (2017). The heart of inclusive education is collaboration. *Pedagogika*, **126**(2), pp. 248–253. https://doi.org/10.15823/p.2017.32

Florian, L. and Spratt, J. (2013). Enacting inclusion: a framework for interrogating inclusive practice. *European Journal of Special Needs Education*, **28**(2), pp. 119–135. https://doi.org/10.1080/08856257.2013.778111

Forlin, C. (2001). Inclusion: Identifying potential stressors for regular class teachers. *Educational Research*, **43**(3), pp. 235–245. https://doi.org/10.1080/00131880110081017

Gaffney, M. and Faragher, R. (2010). Sustaining improvement in numeracy: Developing pedagogical content knowledge and leadership capabilities in tandem. *Mathematics Teacher Education and Development*, **12**, pp. 72–83. https://files.eric.ed.gov/fulltext/EJ940922.pdf

Gardesten, M. and Palmér, H. (2023). Students' participation in mathematics in inclusive classrooms. *Mathematical Thinking and Learning*, **27**(2), pp. 157–177. https://doi.org/10.1080/10986065.2023.2258485

Habalová, M. (2019). Inkluzívny potenciál hudby. In: P. Janoško, ed., *Učiace sa spoločenstvo – výzva pre inkluzívne vzdelávanie*, pp. 113–150. Bratislava: Univerzita Komenského.

Halinen, I. and Järvinen, R. (2008). Towards inclusive education: the case of Finland. *Prospects*, **38**, pp. 77–97. https://doi.org/10.1007/s11125-008-9061-2

Hubbard, J. and Livy, S. (2021). Self-study of a mathematics learning consultant. *Mathematics Teacher Education and Development*, **23**(3), pp. 148–165. https://mted.merga.net.au/index.php/mted/article/view/650

Kováčová, B. and Hučková, M. (2024). *Inklúzia v stredoškolskom vzdelávaní*. Ružomberok: Verbum.

McDonough, A. M. and Clarke, D. M. (2003). Describing the practice of effective teachers. In: N. A. Pateman et al., eds., *Proceedings of PME 27*, pp. 261–268.

Menon, V. and Chang, H. (2021). Emerging neurodevelopmental perspectives on mathematical learning. *Developmental Review*, **60**, 100964. https://doi.org/10.1016/j.dr.2021.100964

Moreira, G. and Manrique, A. (2014). Challenges in inclusive mathematics education. *Creative Education*, **5**(7), pp. 470–483. http://dx.doi.org/10.4236/ce.2014.57056

Nieminen, J. H., Reinholz, D. L. and Valero, P. (2024). Becoming a disabled student in university mathematics. *Educational Studies in Mathematics*, **116**(1), pp. 5–25. https://doi.org/10.1007/s10649-024-10311-x

Pais, A. (2014). Economy: the absent centre of mathematics education. *ZDM Mathematics Education*, **46**(7), pp. 1085–1093. https://doi.org/10.1007/s11858-014-0625-8

Peebles, J. and Mendaglio, S. (2014). Preparing teachers for inclusive classrooms. *LEARNing Landscapes*, **7**(2), pp. 245–257. https://doi.org/10.36510/learnland.v7i2.663

Perry, B. D. (2006). Applying principles of neurodevelopment. In: N. B. Webb, ed., *Working with Traumatized Youth in Child Welfare*, pp. 27–52. New York: Guilford Press.

Roos, H. (2019). Inclusion in mathematics education: an ideology or a practice? *Educational Studies in Mathematics*, **100**(1), pp. 25–41. https://doi.org/10.1007/s10649-018-9854-z

Rouse, M. (2008). Developing inclusive practice. *Education in the North*, **16**(1), pp. 1–20. https://doi.org/10.26203/j15x-ym95

Rouse, M. (2006). Enhancing effective inclusion practice. *Kairaranga*, **7**(3), pp. 8–13. https://www.kairaranga.ac.nz/index.php/k/article/view/75

Sakiz, G., Pape, S. J. and Woolfolk Hoy, A. (2012). Teacher affective support in mathematics classrooms. *Journal of School Psychology*, **50**(2), pp. 235–255. https://doi.org/10.1016/j.jsp.2011.10.005

Scherer, P. and Bertram, J. (2024). Professionalisation for inclusive mathematics. *ZDM Mathematics Education*, **56**(3), pp. 447–459. https://doi.org/10.1007/s11858-024-01580-0

Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reforms. *Harvard Educational Review*, **57**(1), pp. 1–22.

Tan, P. and Kastberg, S. (2017). Calling for research collaborations in mathematics education. *Journal of Urban Mathematics Education*, **10**(2), pp. 25–38. https://files.eric.ed.gov/fulltext/EJ1166794.pdf

UNESCO (2020). *Inclusive teaching: Preparing all teachers to teach all students.* Available at: https://www.unesco.org/gem-report/en/publication/inclusive-teaching-preparing-all-teachers-teach-all-students

UN Committee on the Rights of Persons with Disabilities (2016). General Comment No. 4: Article 24 – Right to inclusive education. Available at: https://www.refworld.org/legal/general/crpd/2016/en/112080

UN General Assembly (2007). Convention on the Rights of Persons with Disabilities. Available at: https://www.refworld.org/legal/resolution/unga/2007/en/49751

Vodičková, B., Mitašíková, P. and Slavíčková, M. (2023). Supportive factors in inclusive mathematics education. *Education Sciences*, **13**(5), 465. https://doi.org/10.3390/educsci13050465

World Health Organization (2025). WHO releases 2025 update to the International Classification of Diseases (ICD-11). Available at: https://www.who.int/news/item/14-02-2025-who-releases-2025-update-to-the-international-classification-of-diseases-(icd-11)

World Health Organization (2007). *International Classification of Functioning, Disability and Health: Children and Youth Version.* Geneva: WHO.

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