

DG 23: Current problems and challenges in non-university tertiary mathematics education

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History of the discussion topic

The general purpose of DGs is to bring together participants who wish to engage in meaningful dialogue about challenging or controversial issues relevant to the topic of the group. This DG focused on current problems and challenges related to mathematics education in non-university tertiary institutions (NUTI).

For the purpose of the discussion, a NUTI was defined as a two- to four-year post-secondary educational institution other than a university in which mathematics is a major part of the curriculum. Each of these institutions has functions unique to it and to the region it serves, but all seem to serve the varied needs of students in a post-secondary environment related to, but different from that of the university.

Current problems and challenges in non-university tertiary mathematics education was a topic for the international mathematics community for the first time in Working Group 4 at ICME-9 in Tokyo/Makuhari, Japan in 2000. Approximately 70 participants from various countries discussed the common need for a better understanding of how to motivate students, how to make mathematics more relevant, and how to use technology and alternative teaching strategies effectively. As a result of the apparent need to further conversation, the participants recommended continuing the focus at ICME-10.

According to the report of the organisation team of DG-21 at ICME-10, the three most often mentioned issues were those related to faculty development, mathematics curriculum, and need for research-based information.

The report noted that:

- Faculty development can help faculty to keep pace with current trends in mathematics education and, also, to have the capability to address the needs of their clientele and be aware of research and effective practices in the teaching adult learners.
- The mathematics curriculum should have a strong content base and motivate students to engage in meaningful learning and prepare them for the workplace.
- Relevant research-based information can improve the educational system of two-year colleges and other non-university institutions. This may include research on curriculum, pedagogy, the workforce, and student needs.

Highlights of the presentations and/or discussions

The findings from the sessions at ICME-10 served as background information in organising the presentations and discussions at ICME-11. Therefore, the Organising Team of DG 23 put forth the following questions to the participants for discussion:

1. What are the current problems and challenges pertaining to the teaching and learning of mathematics at NUTI? How are these issues being addressed?
2. Are there developments in research-based information that enrich programmes in NUTI? How are these programmes evaluated in terms of conceptual understanding, procedural skills, cognitive and thinking skills, etc?
3. What are the current developments in the assessment of student learning at NUTI?

The three time slots for DG 23 were used in the following manner:

Session 1: Sign in and introductions of the Organising Team and all participants; discussion led by the Co-chair and Team members on issues, questions and related concerns mentioned above; topics to be discussed outlined; and abstracts and copies of papers under consideration distributed.

Session 2: Organising Team and Paper Contributors led continued discussions with more focus on teaching and learning at NUTI's and their relevance to students' lives and faculty preparedness to address the needs of their students.

Session 3: Summary of the discussions from the previous two sessions, next steps and future collaborations with international colleagues.

The initial discussions were centred around the three questions above. Since the participants were mathematics educators from different types of institutions—colleges of technology, junior colleges, community colleges, universities of technology, polytechnics and other post-secondary institutions that are not all traditional universities—there was a great interest in learning more about the current problems and challenges at different non-university tertiary institutions.

In addressing the first question, many of the participants indicated that the current problems and challenges they faced included: underprepared students, the impact of students' life commitments on their education, lack of research-based information that focuses on student learning. While the faculty believed that these problems and challenges were impediments to the teaching and learning process, they had confidence in their beliefs that there were ways to address the issue. The examples given included: using real-life data to interest students in the learning of mathematics, especially student-generated data that resonates with their interest; using mini-lectures followed by small group instruction, supplemental instruction, and tutors in the classroom; and conducting research on student learning experiences in and out of the classroom.

The second question focused on whether there were developments in research-based information that enrich programmes in NUTIs. Three of the contributors presented papers addressing this question. One paper focused on the lack of research on mathematics instruction at the community college level as it relates to student success. The presenter further indicated that there is a systemic problem in trying to use research models in non-university settings that are designed to fit four-year institutions.

Another research-based presentation entitled, "Student Learning Experiences: A Week at Singapore Polytechnic," was based on data collected for a doctoral study on learning experiences engaged in by a group of year two students when they studied an Engineering Mathematics Module at Singapore Polytechnic. Data was collected online, an adaptation of the experience sampling Method developed by Csikszentmihalyi. The descriptive statistics of students' feelings and perspectives of their learning experiences during lectures, tutorials, and self-study over one week were presented and discussed. Although in the same lessons (lectures and tutorials), students

reported varied perceptions of each learning activity, the purposes, the feelings involved and the attitude elicited by the activities.

The third research study explored the linking of pedagogical content knowledge and beliefs of mathematics teachers of teacher education institutions (TEIs) in learning and instruction. The study also investigated the readiness or the ability of the TEIs to fully implement the New Teacher Education curriculum in mathematics education. This included a survey of the capability of the school in terms of its resources aside from the instruction employed by the teachers. The teacher educators' academic preparation, their pedagogical content knowledge and beliefs, and their perceptions on how identified problems, concerns and impediments can be addressed are possible factors that can affect the implementation of the NTEC in mathematics education.

Two presenters lead discussions on teaching and learning developmental mathematics at community colleges. One focused on approaching a lesson through a series of mini-lectures followed by small group instruction. Supplemental instruction and tutors in the classroom also proved useful. An alternative format was based on "hands-on" learning giving students the opportunity to practice immediately after they see the material. Many students reported that in this way they could approach their homework with confidence. Students benefited greatly when they did some of their assigned work in class in a monitored environment. Another contributor presented in the area of developmental mathematics on the topic, "Using z Scores to Analyze Who Are the Best Sluggers in Baseball". This presentation was designed to motivate students and to show the relevance of sports in learning and understanding basic topics in arithmetic and statistics.

Main conclusions and noteworthy findings of the work of the discussion group:

More research focusing on classroom processes is needed. The main reason for the lack of research was that many faculty did not have the time to reflect on their practices due to workload issues. The DG agreed that a call for sustained investigations on the nature of instruction and its impact on students' success is warranted. There is not enough research-based information focused on teaching and learning and conducted by NUTI's faculty. To address the issue collaborative, faculty research projects were suggested.

Sharing of expert knowledge, approaches, innovations, or challenges on the teaching of specific areas of mathematics education is proposed. The group is suggesting the publication of a *Journal on the Teaching of Mathematics in Non-university Tertiary Institutions (JMiNT)*.

The findings of the Student Learning Experience in the Polytechnic study underscore the importance for teachers to understand students' learning experiences. Student learning experiences vary and also show marked deviations from those planned by the teachers. The methodology of this study provides rich data on student learning experiences. Faculty members of NUTIs could conduct comparative research-based studies.

Another finding was that there is a clear need for training of teachers of TEIs for proper implementation of the NTEC. While their educational background provide them with competencies to teach mathematics content, they expressed low levels of confidence in teaching the basic courses in the NTEC such as contemporary mathematics, mathematical modeling and investigation, probability and statistics, history of mathematics, action research in mathematics, and the higher level mathematics like modern geometry. In addition, there is a need for more institutional support in terms of learning materials, facilities, technologies, and training of the teacher educators.

Suggested Research Areas for ICME-12

- Teacher Education and other specific areas
- Similarities and differences among NUTIs

- Issues on equity and synergy among NUTIs
- Teaching styles
- Learning styles from students' perspectives
- Assessment:
 - Classroom
 - Programme
 - Alternative
 - System-wide