

DG 21: Current problems and challenges in non-university tertiary mathematics education

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History and common concerns

This Discussion Group was designed to provide a forum for mathematics educators from colleges of technology, junior colleges, community colleges, universities of technology, polytechnics, colleges of engineering, and other post-secondary institutions that are not traditional universities. Each of the types of institutions represented in DG 21 has functions unique to that type of institution and to the region it serves, but all serve the needs of students beyond secondary school in an environment unlike the university.

The international community of mathematics educators of such institutions came together as a program group (WGA 4, Fujita et al, 2004) for the first time at ICME-9 in Tokyo/Makuhari, Japan in 2000. The approximately 70 participants found many similarities in their institutions and many commonalities in their concerns. Regardless of the missions of these institutions, students are focused on immediate goals of an education relevant to the world of work and are often underprepared for their course of study.

Many issues and concerns about mathematics education at non-university tertiary institutions were raised during the presentations at ICME-9 and in the discussions that followed. In addition, all authors had been asked to submit a list of the three issues most important to them and their colleagues. The organizers collected these and compiled a master list that was distributed at the meeting in Japan.

Against this background the DG 21 organising team at ICME-10 called for papers that addressed the three most often mentioned issues: Faculty Development, Mathematics Curriculum, and Need for Research-Based Information. It was noted that faculty development can help faculty at their institutions keep pace with current trends in mathematics education and, also, have the capability to address the needs of their clientele and be aware of research and effective practices in 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 includes research on curriculum, pedagogy, and workforce and student needs.

A forum for issues

While the above were areas of ongoing interest, several papers in ICME-10 were submitted on other topics. One such area was the process of transitioning students from secondary school to two-year or technical school to university. Many participants also had concerns about the level of students' preparedness and course placements.



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The three time slots for DG 21 were used in the following manner:

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

Session 2: Organisers led continued discussions with more focus on curriculum and its 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.

The need for research-based information and the transition from secondary institutions to college, college to university and college to work began with recalling a remark of a speaker at ICME-9 in regard to research in education. It was to the effect that it was difficult to do highly significant research in education because if you were researching anything worthwhile it was usually such a broad topic that it was not easy to control all of the variables but the experimental one. So we could do highly significant research on relatively insignificant minutia or do less well-controlled research on broad and significant topics.

Testing is receiving more emphasis in many countries. While the purpose of testing is principally to determine an individual student's level of preparedness, it also enables educators to learn more about how well students as a group are learning mathematics in a state, province, or country. Most mathematicians question whether the tests are measuring the mathematics that students need to know. In the USA, for instance, many colleges are using standardized exams to determine how much students have learned and also, to place students into college courses. The tests do a good job of testing what students have learned in the very traditional classes in high school but not necessarily what mathematics they need in college. Consequently students are allowed to enroll in courses for which they are not always well prepared.

It was noted that many countries represented in DG 21 do not use placement tests. In these countries all students start in the same course regardless of their level of preparation. In two-year colleges in the USA, students can start in the usual mathematics course or take a bridging course. Participants agreed that where students had no choice and all were required to start in a college level course, the success rate was much lower than in the case of students who were allowed to take bridging courses. In addition, students who take this course come out of the two-year college better prepared for the job market. Two-year colleges used to be the last choice for students in France. Because they offer students the opportunity to prepare themselves for college level mathematics and because they provide a more practical education, they are now the first choice. The system can accommodate only a limited number of students and not everyone can go to the two-year college where they have more options of preparing themselves for the regular college curriculum. So, many go to the university by default and fail.

It appears to be widely recognized that learning mathematics is not separate from social issues. Robert Moses, the great civil rights leader in the USA years ago began seeking equity for poor minority students through the Algebra Project aimed at getting more students on the college-preparatory track. ("Mississippi Learning", Jetter, February 23, 1993). This idea has been echoed by leaders the world over. Mathematics has been referred to by many as "the Gatekeeper" or "the Critical Filter," preventing many students

from pursuing a college education or a future-oriented career. Students who are not adequately prepared in secondary school have difficulty transitioning to college.

Focus on transition

Measuring progress and readiness for classes (placement) are but two aspects of transitioning particularly from high school to college. Successful projects and aspects of successful projects were discussed by the participants. Many successful programs that aid entrance into college and help students adjust and be successful in college courses include workshops and special classes to answer questions and give guidance. Some of these occur in the summer or the term prior to the student's entrance to college and some are concurrent with the student's first term or year at the college or university.

Participants also discussed the reasons why the gap exists between what students are prepared to do and what they are expected to do. Reasons include:

- Teaching style in schools encourages learning disjointed facts and memorization.
- Measures of success in schools focus on computation, not conceptual understanding
- Secondary students have lots of simple problems to solve. There is little problem solving that requires sustained effort through multiple parts.
- There is a major jump from secondary school to tertiary education in the thinking level required. Secondary students may only need to give the right answer, not explain how they got it.
- Students are taught to solve problems out of context and not consider reality or check for validity.

Participants agreed that problems of students going from secondary school to tertiary appear to be universal. Many institutions offer bridging courses, called developmental, remedial, or bridging. However, many of these bridging courses do not really bridge the gap. The two main reasons are:

- The courses are too short in duration. Many bridging courses are just a few weeks or months long. During this time some students are not able to master the material usually covered at school for several years.
- The mathematical background of the students is often so poor that the emphasis on bridging courses must be on the fundamentals of mathematics: rules, techniques, manipulations, and algorithms. There is no time to teach students higher level of thinking (proofs, reasoning, etc.). So the gap in thinking is not bridged.

While these were the inadequacies of bridging courses described by most participants, one individual from Israel described a bridging course aimed at preparing students for advanced mathematical thinking.

One participant from Canada suggested a possible reason why so many students have difficulty making the transition from secondary to tertiary institutions. Most cultures have rites of passage in which people are given an introduction to the next phase of life. They know what is expected of them after marriage, bar mitzvah, etc. If students knew the rules of playing the role of tertiary student, they might function very well. McMaster University in Canada mails their expectations to students the summer before they come



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to college. The question educators need to ask themselves is “Who is responsible for making the transition – the faculty or the students?”

There are three kinds of students who have transition difficulty:

- Students who have just a few difficulties.
- Students who never had an opportunity to prepare themselves because of poor schools, poor career advisory services, etc.
- Students who had the opportunity to prepare but did not take advantage of it.

Faculty and institutions have devised many types of transitional courses and learned many factors about what contributes to student learning.

- One instructor starts with teaching the language of mathematics; the subject matter of high school is used but the language of mathematics is emphasized.
- In another program, all faculty take “duty” in the learning laboratory where they respond to student “call-ins,” e-mails, and visits. Data kept on students indicate that students prefer face-to-face interaction and that those who came in for face-to-face tutoring did better in their classes. Sometimes getting students to come in for the first visit is difficult but those who do are much more likely to come in again.
- Supplementary instruction usually refers to sessions where students drop in to get extra help. They work individually or in groups. These sessions are not used to help them do homework problems but to solve more challenging problems.
- Students want to interact with each other and with instructors,
- Students want problems that relate to their individual or group experiences and interests.
- While it is helpful for students to be provided problems relating to their areas of interest, if the instructor is unfamiliar with these applications. It is better to seek further help from colleagues who have such experience.

The future of non-university tertiary institutions

The three sessions at ICME-10 served to further our knowledge of the institutions we represent. Institutions with similar goals, students, problems, and achievements exist in many countries in the world. One purpose of the group is to better understand the role our institutions play in our countries, our societies and our economies. It appears that, as we move further into the 21st century, non-university tertiary institutions are increasingly important in education. For the many students who did not leave their secondary institutions well-prepared for further education or the workforce, they provide a bridge. For adults who never had an opportunity for education because of political unrest, poverty, or social custom, they often provide that opportunity. But more importantly, these institutions are increasingly becoming the choice of many more students who desire a practical education, grounded in the realities of emerging technology and global economics.



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