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Extreme Science and Engineering: A higher education widening participation initiative at QUT

Introduction

Queensland University of Technology (QUT) has a long history in improving access, participation and retention in higher education for disadvantaged groups. This includes indigenous, low-socioeconomic (SES) and other under-represented groups. In 2010, following recommendations of the Bradley Review, funding was provided by the Federal Government under the Higher Education Participation and Partnerships Program (HEPPP) to the higher education sector to work in partnership with schools to improve access and participation in higher education amongst disadvantaged students. The introduction of HEPPP has supported a significant lift in the scale and innovation of outreach activities including those undertaken at QUT. To give you a sense of scale, in the first year of implementing the program in low income schools, QUT's Extreme Science and Engineering programs have engaged with over 9,500 students in schools, and over 5,500 students on campus. In addition to supporting this federal government program, the Extreme Science and Engineering program is integral to stimulating demand for tertiary study, as aligned with the QUT blueprint and the Stimulating Demand component of the QUT Widening Participation Strategy (see figure 1). The key to this strategy is the building of awareness, aspiration, affordability, achievement and access to break down barriers to enrolment for disadvantaged students in higher education.

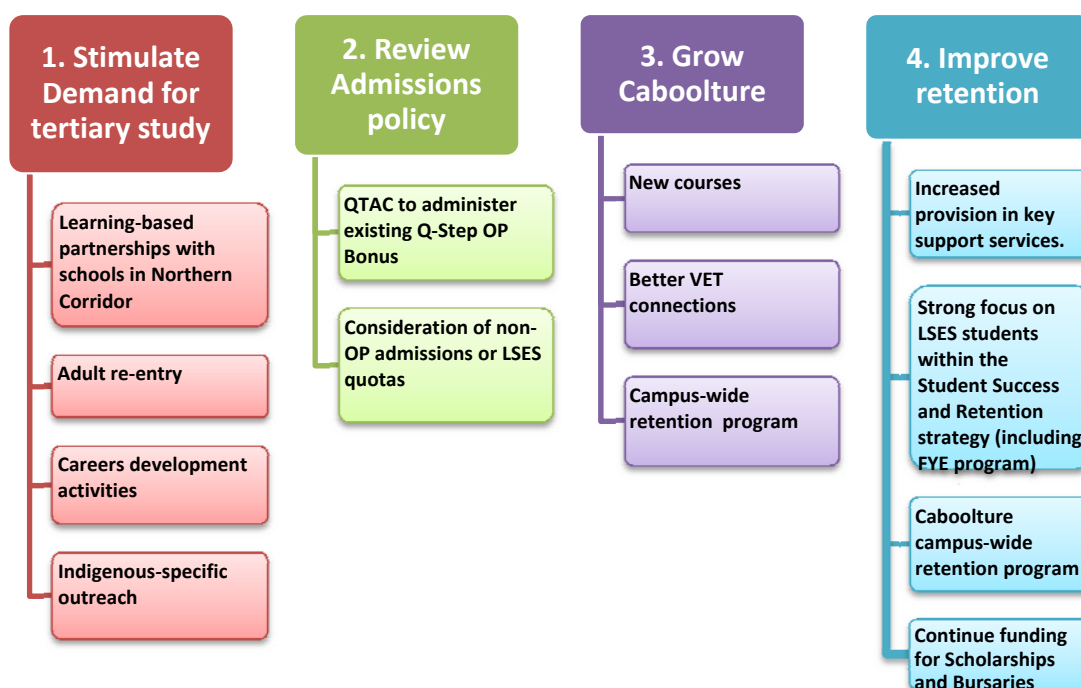


Figure 1 QUT Widening Participation strategy

QUT's Widening Participation Strategy

The University's main strategy for increasing its low-SES enrolments is to stimulate demand for tertiary study amongst potential student groups (school age and mature age). For the schools element, the focus is on learning partnership activities from middle school through to senior school, concentrating on a cluster of schools through the Northern corridor of Brisbane to Caboolture. It should be noted that QUT does have a campus at Caboolture, which offers courses in Nursing, Education, Business and Creative Industries. As part of learning partnerships, there are both on-campus and in-school activities, which are designed to normalise and de-mystify tertiary study and activate interest in science and engineering disciplines. The Faculties of Science and Technology (FST) and Built Environment and Engineering (BEE) outreach programs, including the Extreme Science and Extreme Engineering vans, have been highlighted in the University Compact with the Commonwealth Department of Education, Employment and Workplace Relations (DEEWR), and the hands-on elements of these programs is written as a best practice strategy.

The University's concentration on 10 low-SES high schools and 24 low-SES primary schools in the target cluster is informed by a state-wide agreement between all Queensland universities and the State Minister of Education. Economies of scale in school outreach are achieved through this MOU by allocating QLD low-SES schools into eight clusters. By this approach, duplication and gaps in outreach activities are eliminated. Within their allocated cluster, each university undertakes an agreed suite of activities designed to stimulate general interest in higher education. Through this approach, universities hope to maximise the number of people interested in tertiary study, regardless of where they decide to enrol.

It is seen that universities can contribute to the tertiary awareness and preparation of students, particularly in middle and senior year levels (Years 6-12), through four areas of activity to support this Widening Participation initiative (Widening Participation Working Group 2009):

1. De-mystification experiences for first-in-family and/or equity target groups
2. Encouragement and inspiration through role models, mentors, prizes
3. Value-adding to learning and achievement through discipline-specific connections with schools
4. Alternative pathways for admission and scholarships.

In 2010, FST and BEE expanded their "Extreme" van capacity to travel to cluster-targeted primary and secondary schools. Taken in conjunction with other program elements (both in-school, on-campus, and in-community), QUT hopes that each school student in our target schools will engage with at least one university-related experience each year from mid-primary to year 12, and will have had several interactions with young university students of similar backgrounds to themselves during that period.

Apart from the equity focus of the Extreme programs, the outreach also attempts to address the significant decline in the proportion of students undertaking science subjects in year 12, as seen in figure 2. Most notable is the decline in students participating in biology, as well as chemistry and physics (Ainley 2008).

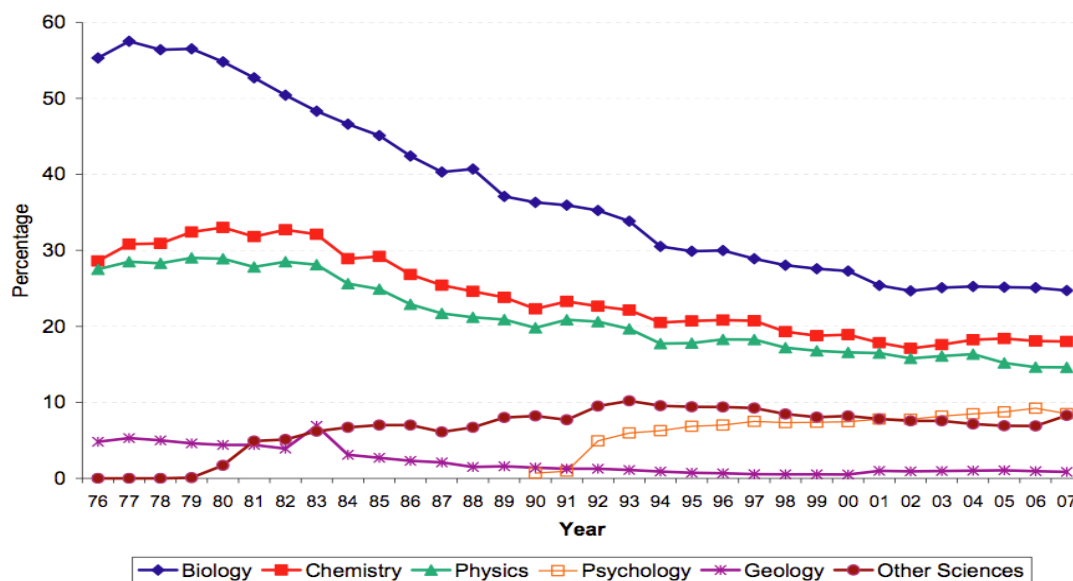


Figure 2 Year 12 science participation as a percentage of the total Year 12 cohort in Australian schools, 1976 to 2007 (Ainley, 2008)

Engagement between schools and universities: outreach programs

Many Australian universities conduct outreach activities and programs which make a successful contribution to the goal of increasing the participation of disadvantaged students in higher education. According to Gale and colleagues (2010), disadvantaged students comprise about 16% of university enrolments, a level that has remained unchanged for more than a decade. Under the Bradley review, a target of 20% by 2020 has been set. Universities are working to address this through their outreach activities as outlined in the state-wide MOU.

Individual university outreach programs in Australia usually focus on a small group of schools. An extensive review of the literature describing current outreach programs around Australia, reported that 39% of these programs involved more than 20 schools, whilst 27% involved 6-10 schools (Gale, Sellar et al. 2010). These programs are often isolated and difficult to sustain over time and across the higher education sector. There is limited evidence as to which of these interventions work and which can be scaled up to reach larger numbers of students. The QUT Extreme programs aim to address the need for a broader reach to targeted low-SES schools.

The survey by Gale and colleagues (2010) also found most programs were focused at year 10 or above. This is in contrast to research which shows that decision making about achievement and aspiration would have been formed well before year 10 (Adams, Zhang et al. 2011). The DEEWR report supported this research and highlighted that when programs were started early, i.e. at least at upper primary, they would have a more profound effect in raising aspirations amongst students. QUT is addressing this by presenting programs to these lower year levels. These targeted programs aim to improve educational access for those with aspirations in tertiary study in these disadvantaged groups.

History of the Extreme Science and Engineering programs

Extreme Engineering program

Commencing in 2002, the program originally targeted the senior subject Engineering Technology as it was seen as an ideal subject for students wishing to undertake an engineering career. The subject draws upon the fundamental principles of science and technology, encouraging a positive interest in the translation of theory into practice. Since 2007, the program has also been used across years 8 to 12 in science, mathematics and geography classes. In 2011, seven student activity kits were offered to schools - two for primary and five for secondary school. Over 3700 students have participated in this program since 2002.

The program is staffed by trained engineering ambassadors from undergraduate or postgraduate engineering courses. Workshops are generally one to two school periods and are provided free of charge. The program is designed to engage students, and their teachers, in activities that are part of, or linked to, the work of the engineering team. It demonstrates, in interesting and exciting ways, the value and importance of the work of engineers to people's everyday lives, and to the environment. The program provides an appreciation of the excellent career prospects that engineering offers.

Another opportunity offered to high school students by the program is the engagement of role models (student ambassadors) in discussion about university life, studies of engineering and career prospects. Material left with the teacher includes advanced concepts and extension work that the teacher can engage the class in at a later date. Because the material presented is part of the subject curriculum, no time is lost to the teacher for covering the required material.

Extreme Science program

The QUT Extreme Science program was established in 2001 as a community intervention initiative to help address the community's increasing disengagement with science. The program was designed to provide highly interactive and relevant cutting edge science workshops to school students in the classroom and to teachers at professional development conferences. Through these interesting and enjoyable experiences, students and teachers would become motivated to re-engage in real world science learning and this would lead to more students being engaged with the sciences.

The program has been running for 11 years. In 2011, 8 student workshops were offered to schools – 6 for the Primary years and 2 for the Secondary years. The program is usually staffed by postgraduate science students, who inherently deliver workshops in a scientifically literate way. Staff are selected for their ability to communicate science to all ages. Workshops are usually of one hour duration and incorporate hands-on workstations using scientific equipment. All workshops are provided to schools free of charge.

The program initially started with a small group of 'relationship' schools. Since that time the popularity of the program has grown and in 2009, prior to equity funding, the Extreme Science van staff visited over 890 schools, reaching almost 64,000 students. Many schools have requested the return of the program year after year and embed the Extreme programs into their science units. Anecdotally, teachers have gained confidence in teaching science and have become science

champions in their schools. Some resources are available and more are under development for teachers to use in creating units of work for students that support the Extreme Science workshops.

The Extreme programs have largely relied on word-of-mouth recommendations between teachers, who have contacted QUT, to book school workshops.

Current activities

Extreme Science and Engineering Van

QUT's Extreme Science and Engineering Van program offers a wide variety of workshops aligned to the current Queensland Science, Mathematics and Engineering Technology curricula (see table 1).

Table 1 Activities offered by the Extreme Science and Engineering program. Activities highlighted in green are part of the Science program, and those highlighted in blue are part of the Engineering program.

Activity	Target year group												
	prep	1	2	3	4	5	6	7	8	9	10	11	12
Microscopy	Green	Green	Green	Green									
Waterworks					Green	Green	Green	Green					
QUT rocks!					Green	Green	Green	Green					
Dudesville					Green	Green	Green	Green					
What's in stuff					Green	Green	Green	Green					
Investigating Electrical Energy						Blue	Blue	Blue					
Alternative Energy						Blue	Blue	Blue					
Nanotechnology										Green	Green	Green	Green
Biotechnology										Green	Green	Green	Green
Water Treatment Plant									Blue	Blue	Blue		
Bridges									Blue	Blue	Blue		
Moments and couples									Blue	Blue	Blue	Blue	Blue
Solar Panels										Blue	Blue		
Concrete Construction												Blue	Blue

Materials are prepared for each workshop and include scripts and PowerPoints for presenters, teacher and student instruction books (engineering only), student worksheets and risk assessments. Instruction books, worksheets and risk assessments are provided to teachers upon confirmation of the booking. Activity kits, including equipment and materials for each workshop, are packaged in boxes for easy handling and transportation. A van coordinator is responsible for maintaining the kits in working order, including stocking of consumables. Workshop format consists of the following: an introductory presentation that sets the scene for the hands-on component of the workshop; group-based workstations activities that cater for groups of 2-4, as seen in figure 3; and culmination of the workshop in a review of activity results.



Figure 3 A student group is assisted by an engineering student ambassador (left), and a Extreme Science ambassador demonstrates an activity to students (right)

Using the funding from QUT's Widening Participation program (HEPPP funded), the van operation was expanded from three days to five days per week for Terms 3 and 4 in 2010, the extra days being only available for booking by the target schools. A flyer was developed for this purpose and sent to contacts in each school, and the QUT Equity section also advertised the program to guidance officer contacts. An aligned on-line system for in-school workshop bookings was established.

To cater for the requirements of the QUT's Widening Participation strategy, priority was given in 2011 to the schools in the target area. The van coordinator emailed general school and known teachers contacts to advise of the opening of bookings for the year. A period of two weeks was given before a wider announcement was made to other (non-target) schools. The majority of bookings for 2011 were received and allocated within the first couple of weeks of these calls.

Explore Uni program

QUT's Widening Participation Explore Uni program was initiated in 2011, and included on-campus days for years 6-12 and residential camps for years 10-12. FST and BEE each provided on-campus, hands-on workshops for these programs. The focus of these workshops was different to van activities, and consisted of short 45-60 minute sessions aimed at engaging students in STEM education. Around 50 Explore Uni days were scheduled across the three QUT campuses in 2011. A suite of year-level appropriate science and engineering workshops was rolled out specifically for this purpose. Upon completion of the project, these workshops may be offered under the Extreme Van programs.

Other Widening Participation Activities

Technology Challenge Maryborough, 11-12 September, 2010: The Extreme Science and Engineering Vans provided hands-on activities to over 100 students visiting TCM's Technology Expo during the weekend Challenge.

Caboolture Science and Engineering Challenge, 18 February 2011, was an additional QUT Challenge day held at Caboolture campus for local secondary schools. Science and Engineering Challenge has been hosted by QUT since 2008 and this was the first year it was offered through another campus.

Response from Caboolture area schools was tremendous and planning for 2012 has incorporated the additional day at Caboolture.

'National...Week' programs: Other in-school programs have been planned to coincide with National ICT Week (secondary school IT workshops), National Science Week (Caboolture Space Night) and National Literacy and Numeracy Week (Maths Comedy shows).

Outcomes

There has been significant demand for Extreme workshops from target and other equity schools. In the first full year of offer (July 2010 to June 2011), a total of 365 individual workshops were delivered to target and other equity schools, presenting to 9526 students. This represented 58% of all van workshops during this period: 40% to target equity schools, and 18% to other equity schools. The remaining 42% were workshops to non-equity schools in Brisbane and south-east Queensland.

Response to the 2010 call resulted in all extra Extreme Science van bookings being filled. Uptake of Extreme Engineering bookings was limited as only high school workshops, catering for select subjects, were available at that stage. However, the target schools who did take up this offer were not representative of the whole cluster, with only 2 of the 10 target high schools and just over half of the 24 target primary schools requesting science workshops for their classes in 2010.

Response to the 2011 van booking call was again mixed despite the preferential call for bookings. Three of the 10 target high schools and half of the target primary schools booked workshops for 2011. Not all schools who took up the offer in 2010 continued with workshops in 2011. This included one high school and 3 primary schools. There were however 2 new high schools and 4 new primary schools who took up workshops for the first time in 2011.

Of the equity school workshops, the majority were presented to upper primary school levels, with years 4-7 representing 60% of all workshops. Secondary schools accounted for 13% of all workshops. Figure 4 shows breakdown across all year levels.

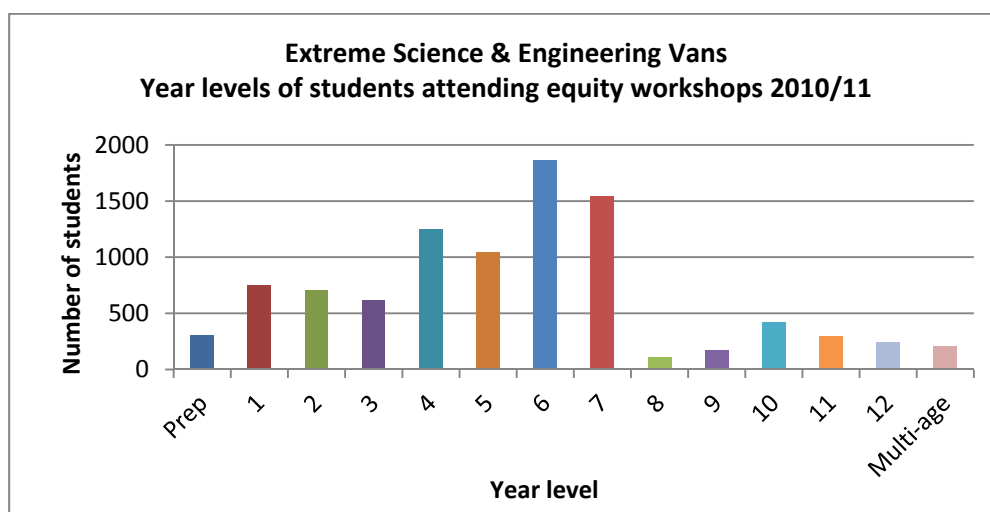


Figure 4 This figure shows the number of students that participated in one of the Extreme Van program activities between July 2010 and June 2011, by their year level

Breakdown of the types of workshops presented in 2010/11 to equity schools is shown in Figure 5. The most popular workshop to equity schools was 'Microscopy'. It should be noted however, that this is the only workshop on offer to Prep to Year 3 students. 'Dudesville', a forensics-based workshop aimed at developing science enquiry skills, was popular with Year 7 classes, whilst the other primary workshops which align with specific science curriculum content strands were popular across the broader range of Years 4 - 7. Upon specific request, some primary workshops were presented to a couple of junior high school classes. Secondary workshops, aimed at senior studies and junior science extension classes, were in least demand, largely due to an already crowded curriculum.

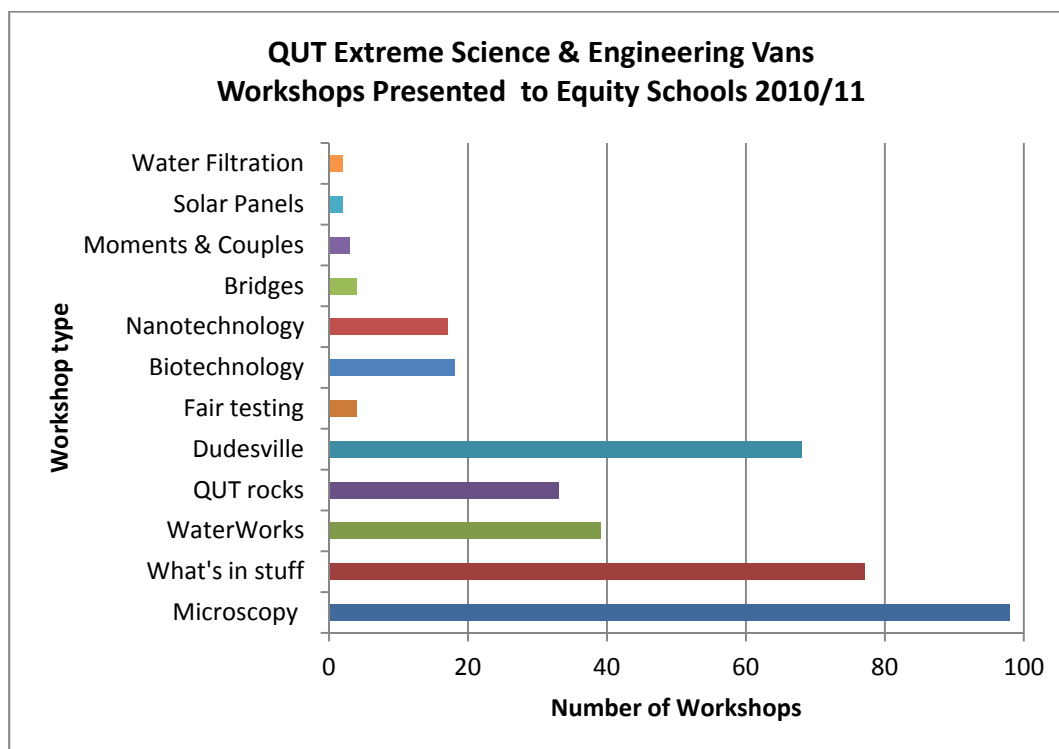


Figure 5 This figure shows the number of workshops delivered at schools from July 2010 to June 2011, broken down by the workshop type

A system for evaluating the Extreme Science and Engineering Van workshops was established in September 2010 using Key Survey. Of particular interest was linkage of workshops to current units of study, relevance to curriculum and year level, quality of workshop, workshop materials and presenter. The contact person for each school visit was sent a link to this survey, however the response rate was lower than expected. Of the responses received, the majority rated the overall quality of the workshops as excellent and the positive feedback indicates benefits for all stakeholders.

The QUT Equity section plan to introduce a formalised longitudinal and evidence-based evaluation system in 2012 for the broader Widening Participation program. Further discussion will need to take place with Equity to ensure the Extreme van survey is aligned with this evaluation system and, in line with recommendation 15 of the Inspiring Australia report, 'Developing an Evidence Base for Science Engagement' (2011):

Benefits of the program to date include:

- Allowing primary and secondary students and teachers to engage in meaningful dialogue about science literacy with science and engineering professionals;
- Enabling students to gain insight into the study and career prospects of science and engineering students at university;
- Providing opportunities for teachers to build their confidence in conducting hands-on science activities; and
- Improving science communications skills.

Teachers are expected to be “subject experts” in order to teach across a broad range of scientific content areas and skills and inspire the scientists and engineers of the future. Through participation in science workshops lead by scientists and engineers, and supported by Extreme program staff with Education experience, teachers will improve their content and skills knowledge. This will better enable them to be science champions and engage and motivate their students in their study of science and engineering.

The nature of the workshops is designed to bring about lasting attitudinal change by engaging students in science and engineering. Central to the design of the workshops is the provision of opportunities for students to participate in hands-on scientific inquiry. Bringing about change in attitudes towards science and engineering studies and careers through hands-on learning and interactions with professionals is intended to have a lasting effect amongst school students and it is hoped that it will bring about more attitudinal changes within the school community. This is important to ensure the sustainability of the program’s aims.

Future directions and recommendations

There are several more workshops that are currently being developed for both the Science and Engineering vans, the topics of which have been commonly suggested by teachers, and align with the national curriculum.

Other future directions and recommendations include:

- Segregation of in-school and on-campus workshop offerings and experiences to avoid duplication;
- Workshop offerings of both vans to be expanded, with an emphasis given to middle school workshop development;
- Further investigation to ensure maximum uptake by target schools of the Extreme program offerings in future; and
- Relationship building with target schools and identification of key contacts to champion the uptake of the Extreme program in their schools.

The sustainability of the Extreme Science and Engineering program relies on the empowerment of teachers, lasting attitudinal change in schools and continued funding support. There are opportunities to further empower teachers by having QUT scientists, engineers and Extreme

program staff offer teacher professional development workshops that focus on scientific knowledge and skills. It is also possible to use the Extreme program to direct teachers into pedagogy-based professional development that is carried out by staff in conjunction with the QUT Faculty of Education.

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