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Building Leadership Capacity in University First Year Learning and Teaching in the Mathematical Sciences

Final report 2015

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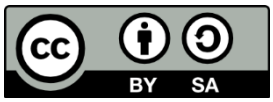

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The Project team

List of Acronyms and Terms Used

AAMT	Australian Association of Mathematics Teachers
ACDS	Australian Council of Deans of Science
AMSI	Australian Mathematical Sciences Institute
AMSLaTNet	Australian Mathematics and Statistics Learning and Teaching Network
Assumed knowledge	Knowledge students are expected to have on entering a course to facilitate understanding of the study material.
AustMS	Australian Mathematical Society
ChemNet	A national network of university chemistry educators
Course	A program of studies required for completion of a degree
FYiMaths	First Year in Mathematics
IISME	Institute of Innovation in Science and Mathematics Education
MANSW	Mathematical Association of NSW
Mathematics	Throughout the report mathematics is used to denote 'mathematics and/or statistics'
OLT	Office for Learning and Teaching
Program	A suite of subjects offered at a particular year level of a degree
School	Used to define an academic department responsible for a particular discipline
SOTL	Scholarship of Teaching and Learning
STEM	Science, Technology, Engineering and Mathematics
Subject	In this document, subject means a single unit of study
Service subject	Mathematics subject that is taught as part of a degree in a range of disciplines to provide the required mathematical underpinning.
Vibenet	A national network of university biology educators

Executive Summary and Recommendations

The project team investigated all aspects of the role of *First Year Mathematics Coordinator*, identifying existing barriers and challenges to their ability to effect change in the learning and teaching of mathematics across the higher education sector. The First Year Mathematics Coordinators' (FYiMaths) Network was established to support innovation in learning and teaching in mathematics and to strengthen the leadership capacity of academics in these roles.

The project team collected data from in-depth interviews with academics coordinating first-year mathematics programs and subjects, and feedback from participants who attended the events organised by the project team.

Outcomes	**Deliverables**
1. Development of a First Year Mathematics Coordinators' network, built through the project team's engagement with the mathematical community.	• First Year in Mathematics Coordinators' network established and growing with over 130 members. • Advocacy role and links with key groups.
2. Establishment of hands-on workshops focused on 'first-year learning and teaching in the mathematical sciences' to increase leadership capacity.	Two workshops and one national forum held in 2013-2014, with further events planned to coincide with major conferences in 2015.
3. Production of case studies and resources that describe and evaluate models for supporting 'first-year learning and teaching in the mathematical sciences'.	• Case studies and Handbook for first-year coordination published. • Website established • Publications

Key Findings

1. **Value of a designated First Year Mathematics Coordinator.** First Year Mathematics Coordinators have a broad perspective of the needs of first-year students and the resultant challenges for teaching. This expertise, gained from their oversight and coordination across first-year programs, has the potential to result in significant benefits for curriculum design and the development of innovative teaching and assessment practices.

2. **Lack of positional authority.** In addition to administrative and management responsibilities, First Year Mathematics Coordinators were expected to implement innovative teaching and assessment practices, effect change and improve student learning outcomes. However, without designated or positional authority, it was almost impossible for them to lead such changes.

3. **Lack of Position Description for a First Year Mathematics Coordinator.** No First Year Mathematics Coordinator had either a position description or a clearly defined statement of duties. This left them vulnerable to the frequent assignment of additional

administrative tasks, many arguably peripheral to first-year learning and teaching matters. The resultant increase in their already very high workloads, meant that there was little to no time left to devote to the tasks that their expertise could best be utilised for.

4. **Lack of professional development.** Most First Year Mathematics Coordinators had had no professional development in management or leadership. They learnt mainly on the job, through trial and error and with limited support from colleagues.

5. **Lack of Career Paths for First Year Mathematics Coordinators**. The incumbent First Year Mathematics Coordinators perceived that their role was seen by others to have low status and to be detrimental to career progression.

6. **Diversity challenges.** First Year Mathematics Coordinators cite student diversity as their major teaching challenge. This included diversity in students' background preparation, in the large classes catering to students with mixed interests and abilities, and in the needs of serviced disciplines. The strategies to meet the needs of diverse first-year student cohorts were often unsuccessful and First Year Mathematics Coordinators frequently felt under pressure, but powerless to effect change.

7. **Isolation across discipline areas.** Interaction with colleagues from other disciplines in relation to development of service subjects was inadequate and inhibited First Year Mathematics Coordinators' ability to develop curricula that provided context to students and to build skills that were transferable to other areas of study.

8. **There is a clear need for a network** which can support undergraduate mathematics educators to build connections between disciplines and between institutions. Steady increase in participation in FYiMaths events over the life of the Project enabled the formation of valuable collaborations that have the potential to produce innovative solutions to the complex challenges that university mathematics teaching presents.

The following recommendations directly address the project team's key findings. They have been devised to foster the conditions under which a First Year Mathematics Coordinator can use the potential in such a role, to enhance learning outcomes for university mathematics and science students.

Recommendations

1. **Establishment of a First Year Mathematics Coordinator role**. Formal acknowledgement of the role is essential to establishing the authority invested in it and the scope of its responsibilities. It makes a clear statement of the value and regard that a department has for its learning and teaching activities.

    a. **The role of First Year Mathematics Coordinator should be viewed as a leadership role.** Appointment of the First Year Mathematics Coordinator should be made through a competitive process. Recognition of, and respect for, the position is then linked to the knowledge that the best person for the job has been appointed. This may, of course, be an internal candidate. Scholarship of learning and teaching that informs teaching practice and innovation should be integral to the role.

b. **Position description**. Clearly stated duties and responsibilities for First Year Mathematics Coordinator's roles must be established. Such a document would define the positional authority of the role, set boundaries on workload and highlight the appropriate requirements for professional development. It provides a standard against which judgements of performance can be made.

c. **Promotion criteria.** Academics are entitled to career paths, no matter which work category they are in. The First Year Mathematics Coordinator role naturally aligns with teaching-focused roles, albeit with the addition of a significant management and administrative load. As such promotion criteria should be aligned with those of teaching-focused roles. If research or scholarship is included in the promotion criteria, then time to pursue these activities should be incorporated in the workload statement.

d. **Key performance indicators.** The First Year Mathematics Coordinator's role is multidimensional. The optimal combination of teaching, management, administration and scholarship requires careful balancing which could be assisted by strategic development of key performance indicators for each of these dimensions. Such indicators would allow the First Year Mathematics Coordinator to assess the level of their performance against key criteria.

e. **Institutional level direction is needed to define the First Year Mathematics Coordinator role.** The primary purpose for the establishment of the role is for the benefits to learning and teaching they can provide. As such, the role should be defined from an institutional perspective and linked to teaching and learning leaders (for example Associate Deans of Teaching and Learning) more broadly within an institution. Heads of School should work with Deans and Faculty Human Resource specialists to develop position descriptions for the First Year Mathematics Coordinator roles.

2. **Supporting the network.** The FYiMaths network is established but needs ongoing support to maintain its website and host events. The project leader should identify funding opportunities and apply for appropriate grants to support the continuing development of the network.

    a. **Annual event.** The FYiMaths network should establish a regular annual event providing a focal point for university mathematics education discussion. Connections with Australian Conference of Science and Mathematics Education (ACSME) and AustMS should be maintained and strengthened, keeping mathematics education issues high on the national agenda.

    b. **Establishment of State nodes.** Individual network members should apply for Office for Learning and Teaching Extension grants to establish State based nodes of the network. The establishment of these nodes will build the leadership capacity of individuals and provide a local forum for ongoing discussion and development of educational innovations.

c. **Future review.** A review of the network should be funded three years hence. This could include revisiting the interviewees to assess the impact of the network.

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Chapter 1: Introduction

Academics who coordinate first-year university programs have a significantly different role than the typical teaching and research academic. In the mathematical sciences, these academics, (variously known as First Year Director, First Year Coordinator, etc.) have a broad portfolio of duties which may include management, supervision, mentoring and training of large numbers of staff (often sessional), quality assurance, running transition programs, curriculum review and provision of course and career advice across all first-year programs, in addition to the usual responsibilities of a teaching and research academic.

A First Year Coordinator is a pivotal figure in the student transition process, who is often the main point of contact for first-year students experiencing difficulties. It has been well documented that a student's experience in first-year university plays a crucial role in their successful transition to university, their subsequent progression through their degree, and impacts on the pathways they choose within their degree (Kift, Nelson, & Clarke, 2010; Krause, Hartley, James, & McInnis, 2005).

However, the increasing number of students enrolled in undergraduate degrees, coupled with changes to higher education policy[1] means that universities are dealing with increasingly large numbers of students with a wider diversity of backgrounds than they have ever seen before. As a consequence, the First Year Coordinator role has increasingly become more complex.

In the mathematical sciences, the First Year Coordinator role is further complicated by the fact that so many students enrolled in first-year mathematics units are not intending to continue their study of mathematics – they are enrolled because improved mathematical skills are required to support their study in their area of major interest.

This suggests that the role of First Year Mathematics Coordinator is strategically important to university departments. However this role, where it exists, is characterised (anecdotally) by high workloads, absence of positional authority, isolation, lack of peer-respect, poor promotional prospects and is generally not supported by a formal position description. The aims of this Project were to examine the First Year Mathematics Coordinator's role, and to build leadership capacity in those academic staff involved with teaching and coordinating first-year programs in the mathematical sciences through the provision of resources and the creation of an improvement-oriented network.

1.1 The FYiMaths[2] project objectives

This Project is set within the context of significant change in academic roles and more broadly across the higher education sector. Over the last decade, increasing diversity in the university student population, and also in their expectations, motivation and engagement, has had a significant impact on how universities must approach their core business. Consequent changes to academic roles have seen increased workloads that include a wider

[1] Including the proposed government target, that 40 per cent of 25-34 year olds will have a Bachelor's degree by 2020, with 20 per cent undergraduate enrolment coming from low socio-economic backgrounds (Bradley Review, 2008).

[2] First Year in Maths (FYiMaths) is the short title given to this project.

range of administration and management responsibilities than previously expected and an increased need to evidence quality of teaching and attainment of graduate attributes.

This project examined the role of First Year Mathematics Coordinator in relation to the tasks that the role entails, how academics in such roles are supported within their organisation, and their potential both for leadership and to be a catalyst to effect change in the teaching of undergraduate mathematics. In particular, it investigated the management, and administrative functions imposed on First Year Mathematics Coordinators in addition to their normal teaching and research responsibilities, the authority (positional or delegated) that they were invested with to perform these functions, and their career pathways. The project team aimed to establish an education-focused network that would support mathematics educators to address the key challenges they faced in university mathematics education, and to provide an opportunity for collegial networking and support the sharing of good practice.

Objectives
1. To build leadership capacity of individuals and teams involved in first-year learning and teaching in the mathematical sciences and to raise their profile within the higher education sector and in the general community, encouraging recognition of their fundamental and key roles and achievements.
2. To promote and support strategic change and improvements in first-year learning and teaching in the mathematical sciences throughout the Australian higher education sector, with significant benefits for the student experience.
3. To develop useful and effective mechanisms and protocols for the identification, development, dissemination and embedding of outstanding individual and institutional practice in first-year learning and teaching in the mathematical sciences.
4. To identify learning and teaching issues that stem from the impact of first-year learning and teaching in the mathematical sciences throughout the Australian higher education sector, with a view to facilitating approaches, strategies and benchmarking at both local and national level.
5. To develop and enhance deeper understanding and knowledge of learning processes in the mathematical sciences, particularly with regard to transition from school to university.

Key questions for the Project were:

- What does a good model for first-year coordination in mathematics look like?
- How are First Year Mathematics Coordinators currently supported by their line managers or by the university more broadly?
- Do First Year Mathematics Coordinators operate within a clearly defined framework?
- What tools and resources do First Year Mathematics Coordinators have at their disposal to perform their tasks?
- What do First Year Mathematics Coordinators achieve in terms of supporting first-year learning and teaching in mathematics?

- What could, or should, First Year Mathematics Coordinators achieve that they currently don't?
- What are the key challenges facing First Year Mathematics Coordinators?
- Could a purpose built network support First Year Mathematics Coordinators to be more effective as change agents within the sector?

The Project activities focused on delivering three specific outcomes as a means of achieving these objectives.

Outcomes	**Deliverables**
1. Development of a First Year Mathematics Coordinators' network, built through the project team's engagement with the mathematical community.	First Year in Mathematics (FYiMaths) network established and growing.
2. Establishment of hands-on workshops focused on 'first-year learning and teaching in the mathematical sciences' to increase leadership capacity.	Two workshops and one national forum held in 2013-2014, with further events planned to coincide with major conferences in 2015.
3. Production of case studies and resources that describe and evaluate models for supporting 'first-year learning and teaching in the mathematical sciences'.	Case studies and guide to first-year coordination produced.

1.2 Why is the FYiMaths Project important?

The structure of the role of *First Year Mathematics Coordinator* varies across institutions. While some are dedicated to the coordination of first-year activities only (also called *Director of First-year Studies*), others have significant oversight of an entire suite of undergraduate mathematics subjects (*Undergraduate Coordinator* or *Discipline Coordinator*). Almost all of these roles involve a significant component of administration and management responsibility.

While similar roles exist in many disciplines, the role of First Year Mathematics Coordinator includes a number of features that are particular to the mathematics discipline.

There is no doubt that most teaching done by mathematics departments in Australian universities is 'service teaching'; that is, teaching of mathematics and statistics to students whose major area of interest (which is not mathematics) requires the study of some mathematics. In a variety of degree programs including science, engineering, health sciences and commerce[3], mathematics is a compulsory subject at first-year level (and sometimes beyond). Classes are usually large and taught in traditional lecture format to accommodate student numbers, which presents challenges to effective learning and student engagement. Large student enrolments also require complex and labour-intensive administration to

[3] We will refer to these degree programs collectively as 'mathematics-dependent degrees'.

manage the logistics of enrolment, curriculum development, timetabling, staffing, assessment and liaison.

These service subjects[4] must cater to students who have a diverse range of backgrounds in mathematics, very different disciplinary perspectives and who have varying levels of intrinsic interest in mathematics. Often students may not even be aware prior to commencing their university studies, that mathematics is a core component of their degree.

That students often don't appreciate the importance of mathematics in their degree is of significant concern. This is exacerbated by the number of universities that have relaxed their entry requirements for mathematics from hard prerequisites to 'assumed knowledge'[5]. In the absence of this imperative, increasingly, students are opting out of studying intermediate and advanced mathematics at school, which they perceive as hard (and likely to impact negatively on their ATAR score) and unnecessary. Furthermore, student performance and engagement in higher level mathematics study in secondary schools is negatively impacted by the lack of appropriately trained mathematics teachers (currently 40% of Year 7 to 10 are 'out-of-field teachers'). As a consequence many students are not exposed to passionate role models and mathematical advocates (Australian Mathematical Sciences Institute, 2014).

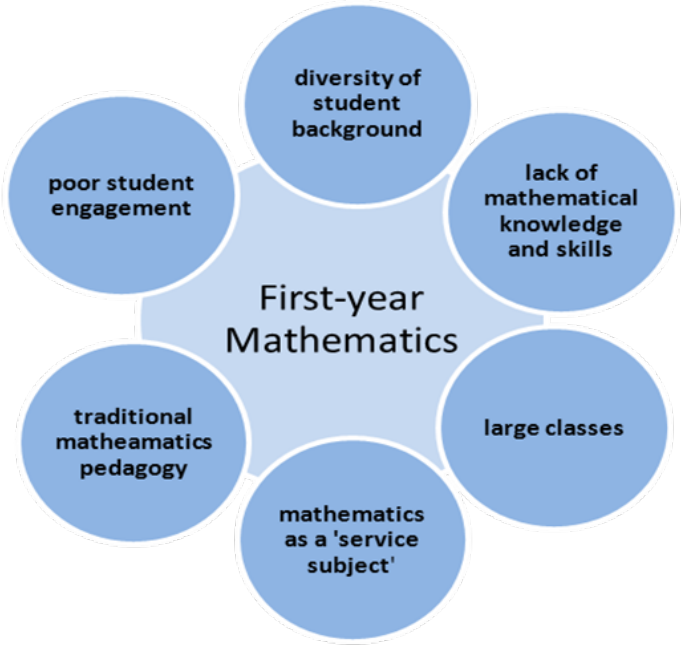

Figure 1. Challenges for first-year mathematics teaching.

This diversity is further complicated by an academic's reasonable, but often unrealised, expectation that students will bring with them a level of knowledge in mathematics that serves as a starting point for the effective learning and teaching of undergraduate

[4] Subjects designed to deliver mathematical skills to students in pathways other than mathematics.
[5] Assumed knowledge is the level of knowledge students are expected to have on entering a course to facilitate understanding of the study material.

mathematics (Rylands & Coady, 2009). Consequently these students often struggle with mathematics in their first year of university, due in part to their limited mathematical background, and leading to high failure rates in mathematics (Rylands & Coady, 2009) and poor retention (Coupland, Stanley, Groen, Bush, & Beames, 2013; Croft, Harrison, & Robinson, 2009).

These issues create a range of significant difficulties in coordinating and/or teaching first-year mathematics that are distinct from other disciplines;

- The diversity in student background means that within a first-year mathematics class there may be students who have studied intermediate and advanced secondary school mathematics, as well as those who may not have studied mathematics since year 10 (Barrington and Brown, 2014). This presents significant challenges in designing a curriculum that can build on the existing knowledge and skills students bring with them, and still meet the learning outcomes required for the subject (Whannell & Allen, 2012). In many cases, the disparity in student backgrounds has serious consequences including high failure rates and poor retention of students (Rylands & Coady, 2009).

- Insufficient mathematical background has consequences for the administration and management of students including, difficulty meeting student expectations, increased need to provide academic support services, and a need to increase the amount and frequency of formative assessment tasks. Increased staff workloads arise as a result of providing more hours of student consultation, staffing of academic support programs and marking weekly tests and tutorial exercises (McInnis, 2000).

- Success in university level mathematics requires that students think at a higher and deeper level than was needed at secondary school. Inability to think 'mathematically' or 'deeply' is cited by many studies and reports as the key element in the gap between high school and university mathematics (Barton, Goos, Wood, & Miskovich, 2012; Thomas & Klymchuk, 2012).

- Mathematics educators often find it difficult to engage students who are studying mathematics as a service subject. Students from a range of degree programs are often taught mathematics in the same class, which limits the ability to contextualise the curriculum to specific applications (Gill & O'Donoghue, 2007).

- Mathematicians often find teaching service subjects to disinterested students to be challenging and frustrating. This has been described as a mismatch of expectations between vocationally focused students and their mathematics lecturers who see mathematics as 'an object of study in its own right' (Hoyles, Newman, & Noss, 2001 p. 841). A tension exists when service teaching provides the main source of income for the mathematics department, but involves teaching students with little interest in the subject.

Institutional responses to these challenges include introduction of teaching-focused roles in mathematics, support for the development of new innovations in the teaching of mathematics and provision of additional learning support programs for students. However, these measures often seem to lack focus and impact because there is no obvious key driver

or academic champion. Even in those institutions with designated First Year Mathematics Coordinators, the interventions may not become entrenched unless the First Year Mathematics Coordinator has the required level of authority.

The role of First Year Mathematics Coordinator within the context of the changing roles of academics was examined:

- There is increasing specialisation of academic roles across universities, with a wide variation in the balance of research, teaching and administration (Coates & Goedegebuure, 2010). While research is still perceived to be the primary consideration for promotion, the career path for academics in roles with significant teaching or administrative responsibilities is unclear (Probert, 2013). Roles such as First Year Coordinator, Associate Dean and Head of School carry significant managerial and administrative responsibilities that limit time available for research. While some universities have established career paths in teaching-focused and managerial roles, some academics have expressed doubt that the career prospects of academics in these roles are adequately supported within current professional development and promotional opportunities (Bentley, Goedegebuure, & Meek, 2014).

- In most cases First Year Mathematics Coordinators do not have a position description that clearly defines their responsibilities and delegated authority. The project team considered both positional leadership in terms of formal responsibilities, and non-positional leadership that occur when responsibilities are delegated without positional authority (Kotter, 2008; Roberts et al., 2011). Kift (2009) found that integration and coordination of those working with first-year students was very important and that many institutions struggle to coordinate all the elements of curriculum design, teaching pedagogy, administration and support service. Martin et al., (2003) found evidence of a positive link between leadership and student learning outcomes, particularly when teaching staff cooperate to make connections between subjects in a degree.

The role of First Year Mathematics Coordinator is often isolated within a university and even from colleagues in a mathematics department. The project team viewed the potential for the development of a network for First Year Mathematics Coordinators from the perspective of communities of practice.

- There are examples of academic networks or 'communities of practice' providing leadership and support for teaching innovation within the Australian higher education.

- The project team's objective of developing a First Year Mathematics Coordinators' network reflects Wenger, McDermott and Snyder's (2002) principles; that is, the core focus should be on identifying common concerns and appropriate structures for interaction and supported learning.

- Discipline-based networks such as ChemNet, Vibenet, CUBENET and AMSLatNet[6] that have been supported by the OLT have enabled networking opportunities with other

[6] These discipline networks were established with support from the Australian Government Office for Learning and Teaching in 2011.

science disciplines. The success of these networks shows that the potential exists for networks to address discipline-specific challenges.

Chapter 2: Methodology employed to achieve outcomes

The project team focused, from the outset, on building national engagement through face to face interviews, organising workshops and developing an online presence. The approach aligned with the principles of *communities of practice*, by identifying experiences shared by those academics coordinating and teaching undergraduate mathematics. The project builds on the OLT Projects *Clarifying, developing and valuing the role of unit coordinator as informal leaders of learning in higher education* (Roberts et al., 2011) and *Articulating a transition pedagogy to scaffold and to enhance the first year student learning experience in Australian Higher Education* (S. Kift, 2009).

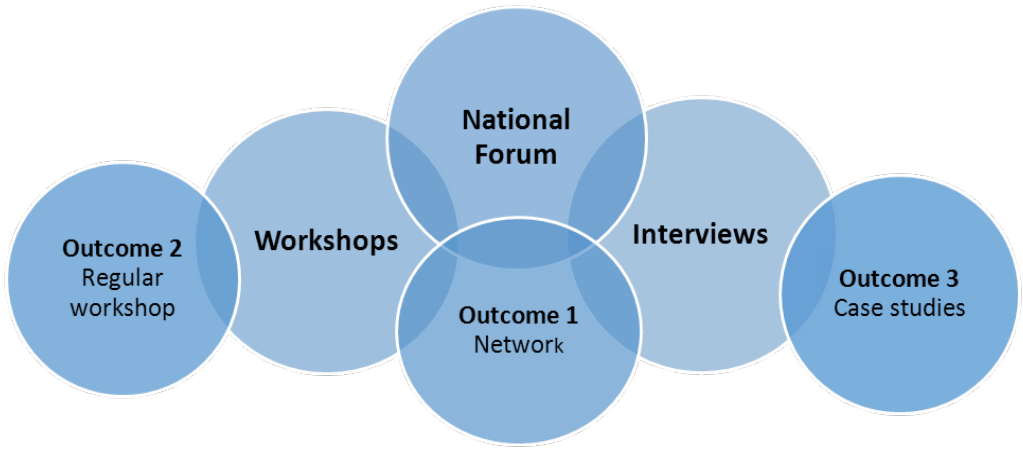

Figure 2. Project activities and outcomes.

The key project activities and three outcomes are represented in Figure 2. The workshops, National Forum and interviews all contributed to the development of *Outcome 1: The Network. Outcome 2: The establishment of regular workshops,* was based on the feedback and discussion data collected at the project workshops. *Outcome 3: Case Studies* were developed through collection of interview data.

2.1 Interviews: Addressing Outcomes 1 and 3

An initial scoping study of mathematics departments was conducted in every Australian university to identify academics with some degree of responsibility for coordination of first-year mathematics programs and to collect details about these programs.

At six universities overarching responsibility for first-year programs was invested in a single person who we will refer to as the *First Year Mathematics Coordinator*. Of these six coordinators, three were project team members, and two others had been appointed within the previous few months. Some institutions had a single person with a portfolio of

responsibilities that included many of those of the First Year Mathematics Coordinator, but went beyond these (an undergraduate coordinator or discipline coordinator). The remaining institutions had delegated their coordination roles to individual staff members who oversaw single subjects, with no overarching first-year coordinator. Table 1 summarises the coordination roles we encountered.

Table 1. Categories of coordination roles we encountered.

Subject Coordinator	Coordinator of a single subject.
First Year Coordinator	Coordinator of first-year activities. Generally will also be the Subject Coordinator for at least one subject.
Undergraduate Coordinator	Coordinator of undergraduate activities across a department, including first-year activities.

In order to ensure that a comprehensive picture of first-year coordination was developed, the project team also interviewed some Subject Coordinators who had significant responsibility for management and administration of first-year mathematics subjects and also some coordinators of mathematics support centres. This extended list also formed a basis from which invitees to our first workshop were chosen.

In total the project team conducted 40 interviews across 26 universities in Australia and New Zealand, covering all states and territories except the Northern Territory and Tasmania.

A set of interview questions was developed by the project team, which addressed the key topic areas for data collection. The interviews were semi-structured, with follow-up questions adapted to accommodate the flow of conversation, the particular topics interviewees raised and to allow for comments relevant to the variations in the role of each interviewee (Flick, 2007). For example, the topic of lecture recordings and their impact on student engagement was raised by a number of interviewees, but was not covered by the original questions. Inclusion of these topics allowed participants to provide responses to the issues that most affected them. Interviews were recorded and fully transcribed.

Interview Question Topics

Topics for each interview were taken from the following list:

- Overview of the local mathematics program(s)
- Defining the nature of the coordination role at the institution
- Position description (formal or informal)
- Satisfaction with the role
- Professional development
- Workload and morale
- Feedback and mentoring
- Teamwork

- Recognition and appreciation of the role
- Community involvement
- Pedagogy and models of teaching
- Strengths and weaknesses of the role

Interviews were conducted, in most cases, by two Team members (including the project manager). On four occasions only one Team member was available to conduct the interview[7]. Each interview ranged from 60 to 90 minutes in length, and all but two interviews were conducted face to face (the other two being telephone interviews due to time constraints). One interview was conducted as a focus group, as six members of the mathematics department at one institution were keen to participate but time did not allow for individual interviews.

The full texts of all interviews were analysed to identify the key themes within each of the interview topics. Interviews were read by the project manager several times and coded using NVivo. The keywords used for coding were matched to the key objectives set at the beginning of the Project. They were used to identify the common aspects of the various coordinators' roles, including; organisational structure and support, the learning and teaching issues that were in their domain of responsibility, challenges related to coordination of mathematics programs, and challenges to existing learning strategies employed to address students' transition difficulties.

We have developed case studies based on interview data that outline the differing roles and responsibilities of First Year Mathematics Coordinators. The case studies are contained in '*First Year Coordinators in Mathematics - A guide to developing the role of First-Year Mathematics Coordinators in your university*', which is available on http://www.olt.gov.au/resource-first-year-learning-maths-sciences.

2.2 Workshops: Addressing Outcomes 1 and 2

The approach taken to developing the network and organising the workshops focused on identifying common interests, providing opportunities for developing personal networks, information sharing and facilitating collaborations and mentoring relationships. The workshops served as a focal point for building the network's sense of identity and purpose. They also provided an opportunity for information dissemination, capacity building, awareness-raising of the project team's data collection, and offered an opportunity to recruit interviewees.

Two workshops were organised by the project team, both held at The University of Melbourne. Workshop 1 was held early in the project to initiate development of the network, and to establish links with key stakeholders and change enablers[8] as well as with academics active in learning and teaching. Workshop 1 was attended by 41 academics

[7] On three occasions the Project Manager interviewed alone due to unavailability of other team members. On one occasion the Project Leader attended a conference in New Zealand and used the opportunity to interview.

[8] These included the Australian Mathematical Sciences Institute and the Australian Council of Deans of Science Teaching and Learning Centre.

representing 23 institutions, and was characterised by an enthusiastic sharing of practice and sense of collective purpose. A pre-workshop survey was sent to registrants to determine their professional backgrounds and interests. The workshop program and timing was developed using this information and included topics and issues of interest to participants. Invited presentations from learning and teaching leaders were balanced with opportunities for discussion, information sharing and networking.

Workshop 1 discussion topics included assessment practices, developing leadership, scholarship of learning and teaching, and initiatives to promote learning and teaching in science. The workshop was supported by sponsorship from the Australian Mathematical Sciences Institute (AMSI), whose Program Manager (Schools) presented a showcase of new resources related to careers in mathematics. Post-workshop feedback was extremely positive with requests for the next workshop to be longer, with more opportunities for networking, increased discussion time, and establishment of an annual event.

Workshop 2 consolidated the growing sense of network identity by involving network members in presentations, showcasing successful OLT Projects, and included active involvement of the Australian Council of Deans of Science (ACDS), AMSI and the Australian Mathematical Society (AustMS). The workshop was held over one and a half days, in response to feedback but also to accommodate the number of submissions from presenters. It was attended by 72 academics from 25 universities, with half of the participants having attended Workshop 1, the National Forum (see Section 2.3), or having been interviewed by the project team.

Workshop 2 focused on showcasing a variety of approaches to teaching and assessing mathematics. Presentations were given by thirteen academics from across the country, and included talks on research findings, case studies and practical teaching innovations. The opening address was delivered by Professor Peter Forrester, President of the AustMS, and a presentation by AMSI Director Geoff Prince was also included in the program.

A post-workshop survey of participants provided feedback on Workshop 2 and suggestions for future workshops. Workshop 2 received sponsorship from AMSI and the Australian Mathematics and Statistics Learning and Teaching Network (AMSLaTNet).

2.3 National Forum: Addressing Outcome 1

The project team had identified through interviews and Workshop 1 that the single most pressing challenge faced by educators of first-year mathematics students, related to the mathematical background and preparation of these students. There was a strong and shared concern about the negative impact of assumed knowledge entry standards on learning outcomes for students, and a frustration that labour-intensive measures put in place to address the knowledge gap were not effective.

The project team undertook to organise a National Forum in February, 2014 as an additional project event. The *National Forum on Assumed Knowledge in Maths: its broad impact on tertiary STEM programs* was organised in conjunction with the Institute of Innovation in Science and Mathematics Education (IISME) at The University of Sydney (see flyer at Appendix C).

The aim of the Forum was to engage peak mathematics and mathematics education bodies, and a wide range of science colleagues, in a national conversation to determine the breadth of the impact that mathematical under-preparation has on student retention and progression in mathematics, but also more broadly, its impact on science and engineering studies. The project team consulted widely to develop the program and select speakers for the Forum.

The Forum provided a valuable opportunity for engagement with an issue impacting science, technology, engineering and mathematics (STEM) disciplines. It attracted attendees across all these disciplines, and so enabled the development of a clear picture and deeper understanding of the consequences of prerequisite removal. It showcased the wide range of responses that universities employ to address this problem - not just for mathematics subjects, but for subjects in cognate disciplines. It provided a forum for information sharing and multidisciplinary discussions.

The Forum was attended by 145 representatives from Australia and New Zealand, including mathematicians, scientists from many disciplines, members of peak mathematical bodies, State and Federal government curriculum authorities and representatives from secondary education. The Chief Scientist, Professor Ian Chubb gave the opening keynote address and the National Mathematics and Science Education and Industry Adviser, Roslyn Prinsley, attended both days. Professor Terry Speed, (2013 winner of the Prime Minister's Prize for Science) gave the opening keynote on the second day, articulating the need for mathematics and statistics skills in medical research.

2.4 Evaluation strategy

The project evaluation strategy involved mapping the key project outcomes against measures of achievement. The project team conducted formative evaluation throughout the project to assess progress against these measures. This process resulted in making a number of changes in the overall approach to the project that responded to the issues raised by network members, the wealth of data collected and to the complexity of the issues involved. In particular the development of the case studies involved a greater level of detail than initially anticipated.

Outcomes	**Evaluation Measures**
1. Development of a 'first-year mathematical sciences network', built through the project team's engagement with the mathematical community.	Number and types of communications with network members, surveys of workshop participants, attendance numbers, website hits.
2. Establishment of hands-on workshops focused on 'first-year learning and teaching in the mathematical sciences' to increase leadership capacity.	Feedback from participants, attendance, involvement of key stakeholders, issues covered and linkages created.

3. Production of case studies and resources that describe and evaluate models for supporting 'first-year learning and teaching in the mathematical sciences.	Identification of key issues, website hits, validation of role descriptions and feedback from stakeholders.

Chapter 3: Analysis of Data

The data collected by the project team included qualitative data from interviews with 40 academics who had some level of responsibility for coordinating first-year mathematics programs or individual subjects, as well as feedback from the workshops and the Forum. The data provides a broad picture of approaches to first-year mathematics education and coordination in Australia. It identified many areas in need of further investigation, including structure and content of mathematics subjects, student learning outcomes, impact of students' prior mathematical background on student progression, and consequent strategic approaches to curriculum development.

3.1 Analysis of interview data

The interviews with First Year Mathematics Coordinators, and others involved in some level of coordination, provided a large amount of qualitative data that has been summarised for this report. We are confident that we will be able to publish further analyses for the benefit of the wider community.

Since the scope of this project was to investigate the role of First Year Mathematics Coordinators, the analysis in sections 3.1 and 3.2 is limited to the discussion of findings in relation to those roles that include broad first-year coordination (that is, First Year Mathematics Coordinators and Mathematics Undergraduate Coordinators).

The following analysis includes data from these twenty interviews only.

3.1.1 Professional practice and workload management

All twenty interviewees expressed concerns about high workloads, and an imbalance between the amounts of time spent on administrative tasks, teaching responsibilities and research. Lack of control over workload was also a common theme that emerged from the data. An alarming 80% of interviewees had no position description defining their job, nor a role statement, leaving them vulnerable to the assignment of further additional responsibilities, loosely in the learning and teaching category. Interviewees often felt compelled to deal with new or additional responsibilities that colleagues did not wish to deal with. These significantly increased workloads and were thought to be invisible, since colleagues, including Heads of School, did not have a clear picture of the totality of

> *'So the administrative job is actually kind of overwhelming, and the longer you're in it, the more overwhelming it becomes, because there's always something that has to be done.'* ***Director of Undergraduate Studies, University Y.***

the workload assigned. Of these interviewees, 65% could not identify a clear career path.

Although most interviewees performed high-level administrative functions, which were non-standard for regular academics (for example performance development reviews), only 40% of interviewees noted that they had been given relevant professional development.

Fifteen interviewees also coordinated individual subjects, and identified significant workload associated with teaching, managing assessment, student administration, overseeing tutors and developing teaching materials. First Year Mathematics Coordinators and Undergraduate Coordinators with subject coordination duties in addition to overall first-year coordination found this combination of responsibilities difficult to manage with 60% of interviewees citing high administrative workloads as a significant concern, working extended hours just to deal with administration and student enquiries. That this left no time for strategic management of the first-year program, curriculum development or research (discipline or educational) was mentioned by 65% of interviewees.

> *'I'm listed as the first-year undergraduate coordinator - but I actually take on a lot of the undergraduate roles, not just first year. However they only make allowance for the first-year position (in workload calculations). As the undergraduate coordinator was leaving they thought they would make me the undergraduate coordinator.'*
>
> ***First Year Mathematics Coordinator, University O.***

While 80% of First Year Mathematics Coordinators and Undergraduate Coordinators indicated that they were involved in some research, they emphasised that it was difficult to maintain their involvement and six indicated that their research output was minor. Of the 20 First Year Mathematics Coordinators and Undergraduate Coordinators interviewed, seven were involved in education-focused research, six in mathematics research and three attempted to do both.

All First Year Mathematics Coordinators and Undergraduate Coordinators believed that such roles provide a range of benefits to the university. The single point of contact they provided for first-year mathematics enquiries from students and staff ensured consistency and accuracy of advice. Their oversight of all first-year mathematics subjects provided a broad perspective of the curriculum that informed the development of consistent teaching and assessment practices. First Year Mathematics Coordinators were well placed to advocate for the interests of the mathematics department on various academic committees.

In general, First Year Mathematics Coordinators and Undergraduate Coordinators felt valued by their Head of School, who sought their input and advice on issues relating to first-year matters, curriculum reform and changing teaching practices. They reported that they also felt valued by their colleagues and believed that their role had a positive impact on students. In spite of the various difficulties they encountered, they were able to achieve some efficiencies and improvements across the first-year mathematics program.

First Year Mathematics Coordinators and Undergraduate Coordinators also stated that their role provided a connection between colleagues in mathematics and other disciplines, through academic committees and whole of degree review processes.

3.1.2 Challenges for teaching

All interviewees demonstrated their passion for teaching and deep commitment to supporting student learning. This was reflected in their teaching practice, interest in improving student outcomes and attempts to develop and improve teaching across programs. They were resourceful, persistent and enthusiastic about improving teaching practice and increasing student success, by trialling new approaches and investigating innovations.

> *'my job is to maintain - try to maintain - the standard, make sure that we're all doing the right sort of things by the faculty, in terms of assessment and processes. Ensure that we are keeping things up to date with changes to units, as they have to be approved and all that sort of stuff. More generally to kind of lead us into directions that we as a school decide we should go. So it's my job to do the basic, the big administration if you like, job for the school.'* ***Director of Undergraduate Studies, University Y.***

Around 75% of interviewees found that the diversity in students' mathematical preparation created significant challenges to curriculum design and effective learning outcomes. This contributed to high failure rates, poor student retention and poor progression. Lack of explicit mathematics prerequisites, resulted in many students enrolling in degrees without the required level of knowledge and many of these subsequently struggled with the curriculum. Half of the interviewees said that students who had either not studied intermediate mathematics in secondary school or had achieved results below 60% in their final high school results significantly contributed to the high failure rates.

The interviewees described a range of initiatives, such as diagnostic testing, remedial support and bridging courses, that they were trialling to address these challenges, but most felt that their initiatives had limited or short-term effectiveness. They asserted that

structural changes to degree entry requirements or enrolment processes were needed to deliver effective improvements.

> *'It just appears as though some people, don't want to change, they've been teaching this way since day dot, "It's the students' fault, not mine, leave me alone".'* ***Undergraduate Coordinator, University S****.*

Interviewees from eleven different universities raised the apparent negative impact on student's attendance, engagement and consequent learning outcomes of the proliferation of lecture recordings. Often institutional or faculty decisions made to address these issues, were made without consultation with the First Year Mathematics Coordinators and Undergraduate Coordinators who believed that they could add value to this discussion. The majority of interviewees expressed a strong desire to have more time and resources for the development of new teaching approaches that would increase student engagement.

3.1.3 Leadership and effecting change

Many First Year Mathematics Coordinators and Undergraduate Coordinators that we interviewed felt that it was difficult to exhibit leadership. They were wary of making 'unpopular' decisions, did not have sufficient authority to effect change to first-year subjects, curriculum or staffing, had insufficient time to develop ideas, and limited influence over a range of processes or resources.

> *'It's difficult to effect change. Because, people try and minimise the amount of effort required.'* ***First Year Mathematics Coordinator, University E.***

In many cases interviewees stated that their only means of effecting change was persuasion or reliance on the goodwill of colleagues. More senior academics often resisted change and were disinclined to invest time in developing improved teaching practices.

Most interviewees had some degree of responsibility for reviewing, developing and managing curriculum, subject structure and assessment processes. This involved time-consuming work in ensuring subjects were aligned within programs and across year levels, achieved the required learning outcomes and met the needs of service disciplines. Decisions were based on extensive consultation with recommended changes needing to pass through academic committees.

> *'I think most of my colleagues that are teaching in first year appreciate all of the stuff they don't have to deal with that they would have to deal with for other courses that they teach. They can tell the difference.'* ***First Year Mathematics Coordinator, University A.***

However, despite this expertise, most interviewees felt that their influence over how subjects were actually taught was achieved through collegial relationships and working with like-minded

'One person does tend to just do everything themselves and doesn't interact quite so much with the rest of us (about teaching approaches)…there's no formal structure, and I can think of one particular case it might help them if there was a formal structure cause they would recognise that it's something that they had to do… it was a requirement.' ***Undergraduate Coordinator, University N.***

colleagues, rather than positional authority. They acknowledged that most academics developed their own approaches to teaching and that if individuals within the department did not agree with a suggested approach or practice, they were not required to use it.

3.1.4 Importance of collegial relationships

All interviewees emphasised the importance of working collaboratively with their mathematics colleagues in teaching first-year mathematics. Those that had developed close-knit teams indicated that they received advice and assistance readily, could negotiate teaching loads easily and engaged in regular discussions about teaching issues in the first-year subjects.

The interviewees identified connections with colleagues in mathematics as a key element in the effective management of their program. For many, this relied on developing good personal relationships with others teaching first-year mathematics and shared views. However, not all had the necessary close working relationships. In a number of cases, interviewees reported that personal differences resulted in limited cooperation from colleagues. This highlighted the difficulties inherent in the absence of positional authority and the coordinator's dependence on their colleague's goodwill coupled with their personal persuasiveness to effectively enact their job. In these cases it was very difficult for the First Year Mathematics Coordinator to exercise any influence.

'The more effective stuff tends to be the more personal connections.' ***First Year Mathematics Coordinator, University V.***

Table 2. Issues identified in interviews with First Year Mathematics Coordinators.

Type of University ^	Go8	Go8	Go8	Go8	Go8	Go8	Go8	Go8	ATN	ATN	Reg	IRU	IRU	IRU	IRU	IRU	N	N	N	N
University ID code	**A**	**E**	**I**	**J**	**Q**	**Y**	**Z**	**L**	**F**	**O**	**D**	**N**	**S**	**T**	**V**	**W**	**B**	**C**	**K**	**P**
Position, Role and Responsibilities																				
No clear description of role	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓			✓	✓
Lack of clear career path	✓	✓	✓	✓	✓	✓				✓		✓	✓	✓	✓	✓				
Limited professional development	✓	✓				✓						✓		✓	✓		✓			✓
No positional authority		✓	✓							✓			✓		✓	✓				
Workload																				
Affects morale	✓	✓				✓	✓					✓	✓			✓				
Opportunities to manage/lead		✓		✓			✓		✓	✓	✓		✓		✓			✓	✓	
Research difficult	✓	✓		✓	✓	✓	✓	✓		✓		✓	✓	✓	✓					✓
High administration workload	✓	✓	✓	✓		✓	✓			✓		✓	✓		✓	✓			✓	
Teaching																				
Reviewing and developing curriculum		✓		✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓		✓
Students without assumed knowledge			✓	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓			✓
Difficulties in adapting to student diversity			✓		✓	✓		✓	✓		✓	✓	✓		✓	✓	✓	✓		✓
Innovations in teaching	✓				✓	✓	✓			✓	✓	✓		✓				✓	✓	
Passion for teaching	✓	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
Poor student engagement			✓	✓	✓						✓	✓			✓					✓
High student failure rates			✓				✓				✓	✓	✓					✓		✓
Mathematics program																				
Prerequisite mathematics subjects	✓		✓				✓						◆	◆			✓			
Provide mathematics support	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓					✓	✓	✓	✓
Subjects catering to different backgrounds		✓	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓					✓	
Bridging programs*		✓	✓	✓	✓	✓	✓				✓	✓	✓	✓		✓		✓		

^ University types - Go8=Group of Eight, ATN=Australian Technology Universities, Reg=Regional Universities, IRU=Innovation Research Universities and N=Non-aligned Universities.

◆ Intermediate mathematics is a prerequisite for some courses at this university, but not others.

***** Bridging programs covering secondary school mathematics curriculum required for later subjects. These were mainly subjects that counted towards the degree, but at two universities they were short courses studied prior to commencing first-year subjects and did not count towards the degree.

3.2 Key findings from interviews

The interviews with First Year Mathematics Coordinators and Undergraduate Coordinators were analysed to identify the major findings in relation to the aims of the Project. The findings relating to first-year responsibilities are presented below in the following categories:

- Professional practice and workload management
- Challenges faced by First Year Mathematics Coordinators
- Leadership and effecting change
- Importance of collegial relationships

3.2.1 Professional practice and workload management

We identified twenty individuals who had a coordination role with oversight of the first-year mathematics program, either as a First Year Mathematics Coordinator or Undergraduate Coordinator. We identified only six dedicated First Year Mathematics Coordinators. Of these six, four positions had been established for a long period of time (over a decade) with the current incumbent not being the first to hold the position. The remaining two positions were established after the commencement of the Project.

- **Value of a designated First Year Mathematics Coordinator.** First Year Mathematics Coordinators saw the main benefit of their role as their oversight and coordination across a range of first-year subjects. Because of this, they were able to gain a broader perspective of the needs of students and the resultant challenges for teaching them. This allowed them to make decisions informed by input from other first-year coordinators in other disciplines.

- **Scope of a First Year Mathematics Coordinator's role.** Roles differed in the range of responsibilities that each encompassed, but all were characterised by high workloads predominantly comprising administrative and managerial tasks, committee membership, subject coordination and teaching.

- **Student administration and staff management expectations of a First Year Mathematics Coordinator.** The administrative and managerial workload was typically very high due to the large number of first-year subjects required to meet service needs, the large class sizes, and the large number of staff involved in support teaching (often many casuals and postgraduate students). Other factors contributing to high workload included the broad range of mathematical preparation that students bring to their tertiary study.

- **Student advising and counselling expectations of a First Year Mathematics Coordinator.** These coordinators are expected to provide a broad range of basic and complex information to students, including advice on commencement level of subjects, course planning, special consideration and generic transition information.

- **Administrative support for First Year Mathematics Coordinator.** Most coordinators had limited administrative support, and needed to spend considerable time organising

routine matters such as production of teaching materials, management of student records and oversight of timetables.

- **Curriculum development and assessment**. First Year Mathematics Coordinators approach to management of curriculum and assessment varied, with some reviewing and writing course content and assessment, while others had final approval over the contributions from the Subject Coordinators and lecturers. The interviewees identified the importance of their role in having a detailed knowledge across the first-year subjects that enabled them to provide leadership in making decisions about changes and introduction of new processes.

- **Lack of Position Description for a First Year Mathematics Coordinator.** The existing roles (even the new ones) have developed in an *ad hoc* way, reflecting particular interests of the incumbents. They seem to have accumulated a range of responsibilities that were, arguably, only loosely associated with first-year matters. No First Year Mathematics Coordinator had a position description or a clear and comprehensive record of their designated responsibilities.

- **Lack of Professional Development for a First Year Mathematics Coordinator.** Most Coordinators had not had any professional development in management or leadership. They learnt mainly on the job, through trial and error and with limited support from other academic staff in the department.

- **Lack of Career Path for a First Year Mathematics Coordinator.** The incumbent Coordinators perceived their roles to have low status, and to be detrimental to career progression - as one Coordinator put it, 'this position is death to a career'.

- **Lack of managerial leadership empowerment of a First Year Mathematics Coordinator**. While most Heads of School were reported to be supportive of their School's First Year Mathematics Coordinator, it was noted that they had not actively intervened to alleviate or modify workloads, define responsibilities or review the role.

3.2.2 Challenges faced by First Year Mathematics Coordinators

First Year Mathematics Coordinators are passionate about teaching and supporting students to succeed. All stated that teaching was the aspect of their role they enjoyed the most. However, there were a number of challenges faced by First Year Mathematics Coordinators.

- **Contextual challenges.** Teaching in mathematics departments is predominantly service teaching, creating challenges for student engagement and contextualisation of the content. Many interviewees found it difficult to develop detailed examples of the application of mathematics in a particular discipline such as engineering. This was due, in part, to limited assistance provided by colleagues from serviced disciplines.

- **Development of teaching and learning strategies**. Most First Year Mathematics Coordinators felt this was an important part of the role and many attempted to review teaching approaches, trial alternatives or research the work of others. However, the

routine administrative, managerial and teaching responsibilities dominated their time and limited their opportunities to think strategically.

> *The hardest thing is meeting the needs of the diverse cohort and the fact that we struggle to work out what to do with that diverse cohort. We have high failure rates. We get called to account. We're told that we're teaching poorly; when I know we're trying pretty hard to actually meet the needs of the student. Managers are making decisions based on pretty poor data, they don't actually come and talk, they make assumptions about what's going on, without really having any evidence.'*
> ***Undergraduate Coordinator, University S.***

- **Innovations.** First Year Mathematics Coordinators recognised the need to investigate innovation in pedagogy - to try new ways of teaching, such as flipped classrooms, interactive lectures, activity focused 'board' tutorials[9], blended modes of face to face and online delivery, video solutions, assessment and feedback systems. However, little time was available for them to contribute personally and they had little capacity to lead such changes more broadly because of the lack of delegated authority.

- **Diversity challenges.** Many mathematics educators, including First Year Mathematics Coordinators, were exploring a variety of strategies to meet the needs of diverse first-year student cohorts. However, these strategies were often unsuccessful with staff often asked to justify high failure rates and negative student feedback on subject surveys. This contributed to poor morale, frustration and a sense of powerlessness amongst staff and First Year Mathematics Coordinators.

- **Lack of time for curriculum development and renewal**. Curriculum also needs to be developed, reviewed and renewed to respond to new developments – for example, how should or how have traditional mathematics curricula changed with the advent of computer algebra systems and much more powerful computing tools, and the increased emphasis on computational analysis in broader science disciplines. First Year Mathematics Coordinators recognised the need to respond, but cited time (and authority again) as the major impediment for delivering improved outcomes.

3.2.3 Leadership and effecting change

First Year Mathematics Coordinators want to take a leadership role in terms of driving change. They recognised that connections both across the first-year mathematics subjects and outside the discipline, when they occurred, were effective in making informed decisions. However, the following challenges were identified.

- **Lack of clarity of purpose.** Many First Year Mathematics Coordinators found it difficult to implement teaching innovations without adequate resourcing or the authority to coordinate consistent approaches in a department or even within a team.

[9] Tutorial classes held in rooms with whiteboards or blackboards on every wall where all students complete exercises on the boards in groups.

- **Lack of positional authority.** Most First Year Mathematics Coordinators felt frustrated and powerless to effect change and improve student outcomes because of high workloads and lack of authority to make significant changes.

3.2.4 Importance of collegial relationships

As noted in the previous section, First Year Mathematics Coordinators recognised the importance of collegial relationships. However, they faced challenges, communicating with colleagues who were experiencing their own pressures.

- **Isolation within Mathematics Departments**. As previously noted, First Year Mathematics Coordinators often reported that they were 'invisible' within the department and so did not receive adequate support or recognition.

- **Isolation across discipline areas.** The interaction with colleagues from serviced disciplines was often limited and infrequent. This lack of input impacted on the development of service subjects, inhibiting the ability of mathematicians to contextualise mathematical content to a variety of disciplines. It also created discontinuities in teaching and assessment practices and in the application of the mathematics learnt to areas outside the mathematics subjects.

- **Lack of coordinated approach.** Many universities now have faculty-wide Associate Deans (T&L), Student Support Centres, First Year Transition Programs and Academic Support Offices. First Year Mathematics Coordinators suggested that if they were better linked to such positions and offices, a more coordinated response to first-year retention, progression and transition would be possible.

3.3 Interviews with Subject Coordinators

In addition to the First Year Mathematics Coordinator and Undergraduate Coordinators interviewed, we interviewed seventeen academics that coordinated one or more mathematics subjects (but did not have formal first-year mathematics coordination roles), and three coordinators of mathematics support centres[10]. Of the seventeen Subject Coordinators, ten were at institutions which had First Year Mathematics Coordinators or Undergraduate Coordinators who were also interviewed. The data from these additional Subject Coordinator interviews validated our primary findings and highlighted the importance of the First Year Mathematics Coordinator's role in providing leadership and support, particularly in relation to the challenges of diverse student backgrounds.

> *'Somehow we're supposed to produce a comparable product with an input which is substantially less prepared than what it used to be (with prerequisites) in terms of background. I think background is the big issue and also their understanding of what it is to be a student.'* ***Subject Coordinator, University M.***

[10] One mathematics support centre coordinator was also a Subject Coordinator.

> *'I think we definitely do work together as a team, make sure we're on the same page. And with my tutors as well, I try to make them as much of a team as possible and avoid… tutors who are not on the same page,'*
> ***Subject Coordinator, University X.***

The remaining six Subject Coordinators were from institutions that did not have a designated First Year Mathematics Coordinator or Undergraduate Coordinator (or the Coordinator did not participate in the interviews), and so did not contribute to our analysis in sections 3.1 and 3.2. The additional data (see Table 3) from these interviews reflected similar issues to those identified in our previous analysis (see Table 2), providing further evidence of the difficulties in dealing with diverse student backgrounds and lack of assumed knowledge.

Five Subject Coordinators reported that they had high administrative workloads - including the management of student data, responding to student enquiries, organising course materials and assessment. These Subject Coordinators were from three institutions that had large mathematics student enrolments. This high administrative workload was exacerbated by limited access to administrative assistance, but did not seem to limit research, with four of the five Subject Coordinators active in research and able to balance their commitments adequately.

Table 3. Subject Coordinators.

Type of University ^	IRU	Reg	Reg	ATN	N	N
University ID code	**U**	**G**	**R**	**H**	**X**	**M**
Workload						
Affects morale						
Research difficult						✓
High administration workload	✓	✓		✓		
Teaching						
Reviewing and developing curriculum	✓	✓	✓	✓	✓	✓
Students without assumed knowledge	✓	✓	✓	✓	✓	✓
Difficulties in adapting to student diversity		✓	✓	✓	✓	✓
Innovations in teaching				✓		✓
Passion for teaching	✓	✓	✓	✓	✓	✓
Poor student engagement	✓	✓	✓		✓	✓
High student failure rates				✓	✓	✓
Mathematics program						
Prerequisite mathematics subjects	✓					
Provide mathematics support	✓			✓		
Range of subjects catering to different backgrounds	✓		✓	✓		
Bridging programs*	✓	✓	✓	✓	✓	✓

^ University types - Go8=Group of Eight, ATN=Australian Technology Universities, Reg=Regional Universities, IRU=Innovation Research Universities and N=Non-aligned Universities.

Mathematics Support Centre Coordinators and Subject Coordinators reinforced the concerns of First Year Mathematics Coordinators about the challenges of dealing with diverse student backgrounds, particularly those students without the assumed or prerequisite knowledge. Mathematics Support Centre Coordinators indicated that while extra tutorials and drop in help were popular with students, many students who needed support did not attend. A common observation was that across mathematics-dependent disciplines, academics had unrealistic expectations about how much mathematics students had retained from high school, and so the mathematical content required was a challenge to many students.

3.4 Mathematics programs

Mathematics subjects offered at first-year level vary widely in terms of purpose, curriculum and entry requirements. The number and content of mathematics subjects offered by a single institution is largely determined by the need for service subjects and by the entry-level knowledge of commencing students. Fourteen of the 26 institutions we surveyed, offered multiple levels of first-year mathematics subjects to cater to the different backgrounds of students and to different degree courses offered (see Tables 2 and 3). For example, some institutions offered specific mathematics subjects for each serviced discipline area (offering for example, engineering mathematics, business statistics, or mathematics for life science), as well as more generic subjects offered to a mix of education, nursing and science students. A common message has been that teaching mathematics in these generic classes was often difficult because of the complexities involved in contextualising the mathematics content to specific disciplines. The range of mathematical ability and backgrounds was also likely to be more varied in these subjects, which made it difficult to adapt content, assessment and teaching approach.

'The most common comment that I hear (from students) is "We want to do engineering why are we doing maths?" and it would be so much better if I had more practical engineering problems that I could put into the maths so that they can see why they are doing the maths. But I have found it quite hard to get any sort of response (from the engineers) in terms of practical applications of the mathematics that we can build in so that the students can see it in the context of what they're studying.

I think that's a bit sad, but you can only ask the question and I've done it, … I've gone and talked to people individually and often people say "That's a really good idea, I'll get back to you" and nothing ever happens.' ***First Year Mathematics Coordinator, University T.***

Only six institutions had hard prerequisites for some or all of their mathematics subjects - the majority specifying only 'assumed knowledge'. At four of these six institutions with prerequisites, interviewees indicated that students still struggled in first-year and needed extra support, even if they had studied intermediate mathematics at secondary school.

Where institutions did not have prerequisites, there was no consistent level or understanding of the meaning of `assumed knowledge'. Some assumed as little as Year 10 mathematics, whilst others assumed Year 12 intermediate mathematics. Fourteen

institutions provided mathematics support - either through a support centre within the mathematics department, or through a broader academic skills support program available centrally to all students across the university. Twelve institutions offered bridging subjects to teach secondary school mathematics curriculum. These varied in length from a few days prior to the start of semester one, to full semester long subjects creditable to a degree.

3.5 Workshop data

Attendees at the two project workshops wanted to explore ways to improve teaching practice and course design, meet the needs of diverse student cohorts, and to trial new technology and innovations in teaching. However, they had limited time and access to information, expertise and support to develop their teaching practice. Despite this frustration, it was clear that a range of effective measures were being used at some institutions.

Workshop participants identified the key challenges as:

- **Dealing with diverse student backgrounds and abilities,** including students without the expected assumed knowledge or with gaps in their knowledge.
- **Teaching large classes effectively.**
- **Difficulty in engaging and motivating students** and the challenges of meeting the needs of different service disciplines.
- **Developing innovative and effective teaching practices,** such as flipped classrooms and blended learning.

> *'We've got a lot of new ideas, things that were brewing for a while and now we are empowered to make them happen.'* ***Workshop participant.***

The workshop discussions and feedback indicated that support was needed to:

- **Access information and expertise** to assist in solving the day-to-day issues of teaching and program delivery.
- **Explore innovative teaching practices**, such as flipped classroom and online resources.
- **Create opportunities to meet colleagues in other universities,** comparing experiences and getting practical guidance on how others deal with problems.

Post-workshop surveys indicated that participants wanted more informal time during workshops to network and meet others. Eighty five percent (46) of those who responded in the post-workshop surveys indicated that they had made useful contacts at the workshop.

Chapter 4: Project activities and impact

The project team determined from the outset that the development of a successful network relied on identifying a clear purpose that was of interest and importance to its potential members. The project activities focused directly on the needs of mathematics educators for information, connection and advocacy. They provided a focus for an emerging community of practice by creating accessible events, identifying key shared concerns and responding to community members' needs. An unexpected outcome of the project activities was the strong sense of cohesion around major issues, such as entry standards in mathematics, and the enthusiasm for collegial information sharing.

4.1 Workshops

The workshops were successful in establishing connections between potential network members, and revealed a clear need for a supported professional network for university mathematics educators. The workshops provided an opportunity for individuals to talk about common concerns, through a blend of structured and unstructured discussions. They also provided opportunities for the network to engage with key stakeholders, and professional and academic groups[11] on the broader issues in mathematics education, learning and teaching challenges and innovations, and the scholarship of teaching and learning.

The workshops revealed a strong interest in sharing experiences of teaching practices in undergraduate mathematics and connecting with colleagues in other institutions. Several participants have since indicated a willingness to implement new initiatives and research projects as a direct result of attending the workshops.

> *'I found out there are more resources out there than I thought … I will use them to promote better practice within my department.'* ***Workshop participant.***

A very strong response from workshop participants was their desire to have access to a regular forum for mathematics educators at which they could meet and engage in formal and informal discussion focused on teaching practice. They shared many common concerns and challenges, but also acknowledged that they had gained much from the diversity of experiences and perspectives presented at the workshops, and from the personal connections they had made.

4.2 National Forum

The Forum revealed a gap that exists in the sector; mathematics educators involved with first-year teaching do not have a national representative body or network that advocates on issues of particular concern to them. Bodies such as the Australian Mathematical Society and the Australian Mathematical Sciences Institute have a primary focus on research, research training and, in the latter case, upper level undergraduate education.

[11] Professional and academic groups involved in the workshops were AMSI, AustMS, ACDS Teaching and Learning Centre, Institute of Innovation in Science and Mathematics Education and AMSLaTNet.

There was a commonly held frustration that as isolated voices First Year Mathematics Coordinators could not exert influence in their own institutions or beyond. Participants referred to similar discussions that had occurred at previous events, pointing out that these had not resulted in actions or indeed gained any traction.

This presented an opportunity for our fledgling network to establish a presence, and so we (the project team) undertook to advocate for the group on the issue of soft prerequisites and their impact on student choices and pathways. This unanticipated outcome was a step taken cautiously, with advice and input from network members and the Reference Group. The project team asserts that this outcome further emphasises the need for such a network, and highlights the importance of developing an effective leadership model to guide future activities.

A communiqué representing the Forum participants' consensus view was delivered to the Minister for Education, The Hon. Christopher Pyne, MP, Universities Australia, the ACDS and other peak bodies. The communiqué received media coverage that significantly raised awareness of the issue of soft prerequisites and their impact on student choices[12]. Members of the project team have been invited to discuss the issue with key representatives in the science community, indicating that the communiqué and Forum have had significant impact.

The National Forum forged an important new connection between secondary mathematics teachers' associations (Australian Association of Mathematics Teachers and Mathematical Association of NSW) and university mathematics educators. The Forum provided secondary school representatives with a perspective on students' pathways post-school and their need for effective advice.

The Mathematical Association of NSW[13] (MANSW) released a significant report on secondary school mathematics at the Forum. This report reinforced the Forum's key messages regarding the importance of adequate mathematical background for studying science and engineering at university. The project Leader was invited to join the organising committee for a joint ACDS/AAMT conference to be held in early December 2014, which explored transition from secondary school to university mathematics.

The Forum received high profile media coverage in the Sydney Morning Herald and on local radio. Articles in the HERDSA News, AustMS Gazette and on the Inspiring Australia website ensured the outcomes of the Forum were broadcast to a wide specialist audience as well as the general public. These outcomes have also been incorporated in the Decadal Plan for Mathematical Sciences (Australian Academy of Sciences), firmly placing the issue of prerequisites on the national agenda for university mathematics.

The project team, along with Professor Cristina Varsavsky, were guest editors of a special issue of the International Journal of Innovation Science and Mathematics Education featuring articles written by a number of presenters from the Forum. This special issue provided presenters at the Forum with the opportunity to publish their research and bring it to the attention of a wider audience.

[12] The Project team was invited to present their findings at the 2014 annual general meeting of the ACDS, and the issue of assumed knowledge promises to be one that must drive change within the sector in the near future.

[13] MANSW is the NSW branch of the Australian Association of Mathematics Teachers.

Chapter 5: Building a network

The project team have established an active and developing network of mathematics educators that reflects many elements of a community of practice (Wenger, 1998). The network members have a range of shared concerns in teaching mathematics (*joint enterprise*) and is developing a sense of *mutual engagement* through building trust, familiarity and emerging collaborations (Wenger, 2000, p. 229). The development of a *repertoire* is still emerging through the development of the website, conference papers and workshop presentations (Wenger, 2000, p. 230).

The project team unearthed the need for connection and information sharing amongst undergraduate mathematics educators. Feedback from early interviews and Workshop 1 highlighted the need for a dedicated education-focused mathematics network, and provided clear indications of the key challenges that likely network members faced. The first was how to make connections both inside and outside home institutions, both with colleagues in mathematics and in cognate disciplines. Forming such collaborations was seen as essential if shared solutions to commonly held challenges were to be found. The second challenge was how to access practical information. The third challenge was how to teach students who did not have the expected background or assumed knowledge, or who did not have a primary interest in mathematics. No organisation or event fulfilling this function specifically for mathematics educators previously existed.

The community of practice model seemed appropriate here as it highlights the importance of membership being voluntary and dynamic, and of activities being responsive to the interests of members (Wenger, McDermott, & Snyder, 2002).

The network's membership includes mathematics educators with a wide range of roles, but who share a common interest in developing more effective teaching practices and addressing their many shared challenges. By the time the majority of interviews had been completed, it became evident that the network had achieved a strong sense of purpose.

The network membership was initially informal, with information on the project and information related to mathematics education disseminated regularly to members via an email list of over 130 individuals. The recent introduction of a membership page on the project website has attracted 50 individuals declaring their membership more formally and submitting their contact details. The reach of the network has been evidenced by numerous approaches from individuals and organisations requesting assistance with job advertising, and from individuals seeking research collaborators or assistance with information sharing and data collection.

The *National Forum on Assumed Knowledge: Its broad impact on tertiary STEM programs* provided strong validation for participants about their concerns, and legitimised the network as an effective structure to address them.

Network members have established links with researchers associated with other OLT Projects, leading to broader participation in project events. These new collaborations have already resulted in two successful extension grants for the *GetSet for Success* diagnostic test, with more to follow hopefully. The *QS in Science* project leader, Dr Kelly Matthews, was invited to present on her project at another institution after presenting at the National

Forum. The project team has maintained close links with the project leaders of AMSLaTNet and maths *assess*, and this has resulted in cross participation in project events and joint organisation of ACSME discipline day sessions.

Increased activity in university mathematics education is also evidenced by increased participation in national conferences like ACSME, a rise in education related abstracts for the AustMS conference from four in 2013 to thirty in 2015, by invitations to run professional development workshops, and by requests from network members to visit the lead institution to share ideas and practice.

The network has established links with key science and education peak bodies through the forum and project workshops.

The network is, however, not currently self-sustaining and will need resources to maintain the website, facilitate information sharing between members and to ensure that future networking events occur. One strategy to consider is to hold an enduring networking event in association with established conferences and events, such as ACSME and the AustMS conference – but that still requires resourcing and leadership. Without further funding it will be difficult to sustain the level of activity required to ensure the network endures.

5.1 Key findings regarding the role of a network

- **First Year Mathematics Coordinators, and mathematics educators in general, are working in isolation** and have limited contact with colleagues within their institution and beyond. They have indicated that project activities have enabled them to make contact with colleagues in similar roles and to share experiences and frustrations about the challenges in teaching. This has been highly beneficial and they would welcome further opportunities to do this.

- **There is a clear need for a network** which can support mathematics educators teaching in undergraduate programs. This is demonstrated in the interview data, and further evidenced by positive feedback from event participants, a steady increase in interest and attendance at our events, increased use of the project website, as well as by anecdotal feedback from individuals engaged with the Project.

- **The network's members are a dedicated and skilled group of individuals** who have the potential and desire to make a real difference to student outcomes. A network will keep them informed of developments in mathematics education and enhance their leadership skills through sharing of practice, mentoring relationships and peer collaboration.

Chapter 6: Dissemination for High Impact

The project team used a variety of communication strategies throughout the project to engage with the mathematics community and the general public and to share the Project's preliminary findings.

6.1 Papers, Talks and Media

The project team has given a range of presentations and interviews, created a regular newsletter, and published conference papers, journal articles and an item in the *Conversation* about the project and its outcomes. The project has also received media attention. A complete list of papers, presentations, articles and events can be found in Appendix D. The dissemination activities have been effective in building the identity of the network and establishing it as a legitimate entity that wishes to drive an agenda of change, innovation and research that has the potential to shape policies affecting mathematics education.

Project team members have contributed to conference organisation and given conference papers, and this has been successful in broadening the awareness of the project with different interest groups, in attracting members to the network and building connections with other active learning and teaching networks. Presentations to the ACDS and academic groups provided the project team with the opportunity to engage in the broader debates around undergraduate education and graduate outcomes. These opportunities increased awareness of the project activities, and informed the development of project communication strategies, such as refining the website and widening circulation of project updates.

The project team has reported preliminary outcomes to a wide audience through the publication of articles in the media and academic newsletters, such as HERDSA News and AustMS Gazette. The media coverage of the National Forum legitimised the concerns of network members and brought the issue to the attention of Government and Deans of Science.

6.2 Website and Twitter

The project website has been a valuable medium for communicating with network members, providing resources and links, advertising events, collecting information and promoting project activities to the mathematics community. The project manager posted new information on the website on a regular basis, with bulletins automatically sent to the 235 people 'following' the site or subscribing to the network email list. The development of the project website (www.fyimaths.org.au/) commenced early in the project and was first launched in May 2013. Initially the site was developed as a WordPress site hosted by the University of Melbourne, however there were a number of restrictions on functionality and format that limited the development of the site. In July 2013 the site was moved to the WordPress domain and a web developer, Mark Parry, was engaged to assist the project manager in the design and development of the site. The updated site was launched in August 2013. The format of the new site was based on other successful sites developed by Mr Parry for OLT Projects, such as *QS in Science* and *Inquiry Orientated Learning*. The project manager was responsible for developing and updating content.

The website has become a hub for project activity. It is an important means of communicating with network members and providing access to information on project activities, workshops and Forum presentations. The website also provides network members with links to resources relevant to teaching undergraduate mathematics. The website is used to make announcements through regularly posted news items, a regular (bimonthly) newsletter and 'tweets' on the linked Twitter account. The news items (posts) are automatically emailed to the network email list to ensure all members were aware of announcements. The site content has grown significantly over the life of the project in response to information requests from network members.

The usage statistics demonstrate that the site has been effective in engaging network members. The site hit rate jumps significantly following new posts, and it has now received in excess of 8000 hits.

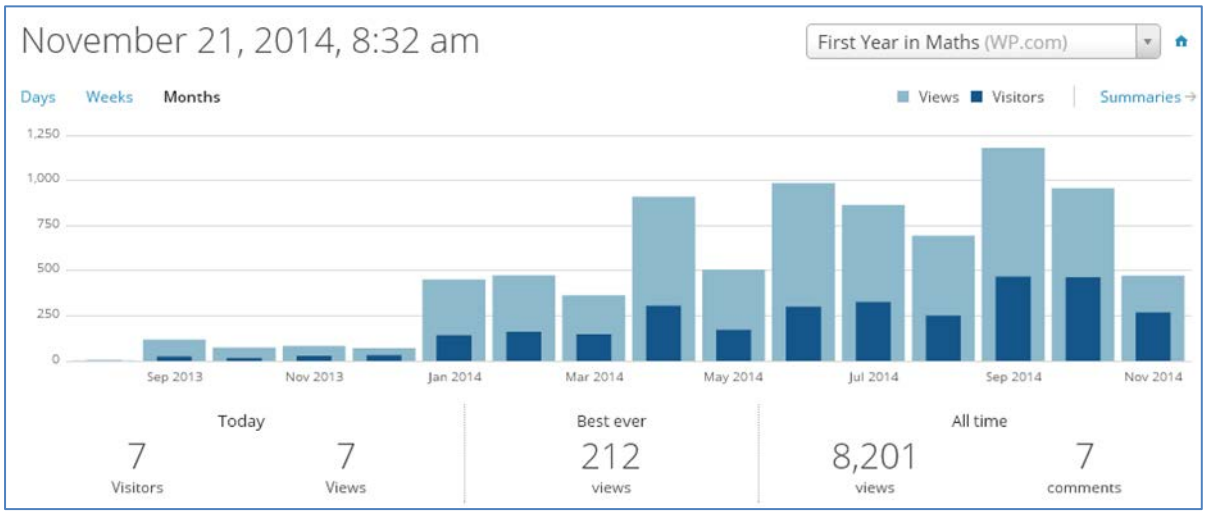

Figure 3. Usage statistics for FYiMaths WordPress site (www.fyimaths.org.au)

The project team has established a Twitter account which is linked to the website and is used for forwarding tweets and announcements. The Twitter account currently has 84 followers. Posts on the website are automatically tweeted, which increases the reach of information. Twitter is also a good source of information from which the project manager has been able to retweet alerts to media stories, announcements for conferences or workshops and comments from organisations on current issues.

6.3 Communication Tools

The project team used a variety of communication tools to share information amongst its members, to discuss project developments and to make decisions. It used the project management website Basecamp to share and update key documents, plan events and seek input from Team members. The project manager posted regular updates on project activities and shared preliminary data, draft reports and presentations via Basecamp. The project team met via teleconference and in person throughout the Project. Meetings were timed to coincide with interviews, conferences and project events in order to minimise travel.

Chapter 7: Discussion

The FYiMaths project has revealed a picture of the role of First Year Mathematics Coordinator that is in need of change.

There is no doubt that mathematics holds a distinct place in universities as an essential technical and conceptual discipline that underpins a wide variety of disciplines. This means that in most Australian mathematics departments, the majority of teaching is service teaching, with relatively low numbers of students intending to major in mathematics. Most students are taught in large classes that make it difficult to engage those who have little interest in mathematics for its own sake. This creates challenges for the organisational structure of undergraduate programs, as well as for the administration and the teaching of these subjects. These challenges are particular to mathematics[14], and are most evident at first-year level due to the large enrolments (often in the thousands) of students in mathematics subjects.

The term 'Coordinator' reflects the prevailing assumption that staff appointed to first-year coordination positions should oversee existing models of curricula, and ensure that appropriate organisational and administrative processes are in place to support these large heterogeneous cohorts of students. The coordinating role is usually perceived to be an administrative role, rather than a conceptual or academic leadership role. However, this is far from the reality.

The project's findings clearly show that First Year Mathematics Coordinators tasked with the responsibility for first-year programs, are indeed expected to manage administrative issues including timetabling and class allocations, employment of casual staff, staff management and mentoring (including Human Resource requirements and processes) of continuing staff and casual staff, tutor training and monitoring and the like.

However, this is not all that is needed. Our findings clearly show that existing First Year Mathematics Coordinators regularly exhibit high levels of academic leadership and problem solving skills, often without positional or delegated authority. They are often responsible for complex and imperfect programs and do a great deal more than they are given credit for.

They may oversee the complex curricula design involved in servicing diverse areas, which often have conflicting needs and constraints, and thus must exhibit high-level interpersonal skills to negotiate with colleagues, most often senior colleagues, both from within their own department and also from their serviced-client disciplines.

Some First Year Mathematics Coordinators felt that they were held responsible for the high failure rates, poor student engagement with content, low student retention and low progression rates. These often occurred because students came with a wide variety of educational backgrounds and sometimes without the preparation in mathematics necessary for their chosen course. They felt under pressure to just `push students through', which negatively impacted on their morale. Finding effective solutions to these difficult problems required innovative and time-consuming responses to subject design, bridging courses,

[14] Chemistry and Computing arguably share some of these challenges because of their service role.

transition programs, methods of teaching, use of technology and modes of assessment - all of which required additional resources that were not forthcoming.

The scope of the First Year Mathematics Coordinator's role varied across institutions, largely depending on the size of the institution. In those institutions that had a designated First Year Mathematics Coordinator (or similar), established protocols for staff management and training existed. However, the incumbents had very high workloads and were frequently expected to take on many additional tasks that vaguely fell into the first-year or teaching and learning domain. In those institutions where subject coordination was shared amongst academics, the First Year Mathematics Coordinator (where they existed) reported more manageable workloads, but there could be significant duplication of tasks. Where there was no such coordinator, there was a perceived lack of an overarching perspective of the first-year program.

Most existing First Year Mathematics Coordinators do not have a documented position description or task-list, and report that they receive minimal direction or support in carrying out their duties. They receive very little professional development, mentoring or guidance to support them in their role, and incumbents felt that they generally had to `learn on the job'. They had not been given explicit key performance indicators, or a statement of what it would mean to have *done the job well*, or even to have done it *satisfactorily*. The First Year Mathematics Coordinators felt that there was no explicit recognition or awareness of the challenges that they must address, although many felt that they were valued by their colleagues for `doing all the work that they (their colleagues) didn't want to do'. There was little or no succession planning.

First Year Mathematics Coordinators were often isolated professionally from colleagues in their own institutions, as well as those in other mathematics departments. This limited their ability to develop teaching practices, engage in scholarship activities and validate their own institution's programs against others from like institutions. They sought practical information that would assist them in introducing new teaching practices and wanted to develop personal connections. The response to project events, resources and communication was overwhelmingly positive and enthusiastic.

Career paths for First Year Mathematics Coordinators remain unclear. Normal academic promotion may be inhibited during or following a significant term as First Year Mathematics Coordinator because they found it so difficult to find time for their discipline research, which is still the main criterion for promotion in most universities. It was felt by some First Year Mathematics Coordinators that the role was broadly regarded by research-active academics as a 'dead-end job', with an acceptance by the incumbents that research activity and hence career aspirations had been abandoned. Some First Year Mathematics Coordinators were actively involved in the scholarship of teaching and learning, but most universities currently have an ambiguous attitude to this as a valid alternative to discipline-based research for promotion purposes.

Experienced First Year Mathematics Coordinators should be seen as valuable resources that possess a deep understanding of the myriad of factors that make up the first-year experience. Unfortunately, it appears that this wealth of knowledge is often underutilised and under-appreciated. Given the expectations of Government and students of universities to provide an outstanding student experience to each graduate, this must change.

It was comforting to hear that despite all the difficulties experienced in undertaking this role, First Year Mathematics Coordinators remain passionate and committed teachers, who are buoyed by frequent positive student feedback and strive to improve student outcomes.

Chapter 8: Recommendations

The project team's investigation of the role of First Year Mathematics Coordinator has exposed it to be one in need of definition. The data analysis in sections 3.1-3.3 clearly shows that whilst there are real benefits to the core teaching function of mathematics departments who have a designated First Year Mathematics Coordinator, the academics in these roles are undervalued and their expertise is underutilised. Their status and authority is ambiguous, the structures within which they operate are seriously flawed and the support and recognition they receive is inadequate.

After further examination of the interview data, the project team has formed the view that professionalization of the First Year Mathematics Coordinator role could go a long way to mitigating the risk of the appointee succumbing to the morass of tasks the role currently entails. Personal and institutional benefits would follow from a clear statement of purpose, expected performance and promotion criteria.

The Role of First Year Coordinator

1. **Establishment of a First Year Mathematics Coordinator role**. Formal acknowledgement of the role is essential to establishing the authority vested in it and the scope of its responsibilities. It makes a clear statement of the value and regard that a department has for its learning and teaching activities.

    a. **The role of First Year Mathematics Coordinator should be viewed as a leadership role.** Appointment of the First Year Mathematics Coordinator should be made through a competitive process. Recognition of, and respect for, the position is then linked to the knowledge that the best person for the job has been appointed. This may, of course, be an internal candidate. Scholarship of learning and teaching that informs teaching practice and innovation should be integral to the role.

    b. **Position description**. Clearly stated duties and responsibilities for First Year Mathematics Coordinator's roles must be established. Such a document would define the positional authority of the role, set boundaries on workload and highlight the appropriate requirements for professional development. It provides a standard against which judgements of performance can be made.

    c. **Promotion criteria.** Academics are entitled to career paths, no matter which work category they are in. The First Year Mathematics Coordinator role naturally aligns with teaching-focused roles, albeit with the addition of a significant management and administrative load. As such promotion criteria should be aligned with those of teaching-focused roles. If research or scholarship is included in the promotion criteria, then time to pursue these activities should be incorporated in the workload statement.

    d. **Key performance indicators.** The First Year Mathematics Coordinator's role is multidimensional. The optimal combination of teaching, management, administration and scholarship requires careful balancing which could be assisted by strategic development of key performance indicators for each of

these dimensions. Such indicators would allow the First Year Mathematics Coordinator to assess the level of their performance against key criteria.

e. **Institutional level direction is needed to define the First Year Mathematics Coordinator role.** The primary purpose for the establishment of the role is for the benefits to learning and teaching they can provide. As such, the role should be defined from an institutional perspective and linked to teaching and learning leaders (for example Associate Dean teaching and Learning) more broadly within an institution. Heads of School should work with Deans and faculty Human Resource specialists to develop position descriptions for the First Year Mathematics Coordinator roles.

The FYiMaths Network

Examination of the workshop, Forum and website data indicates that the FYiMaths network has quickly established itself as a valuable resource within the sector. The overwhelmingly positive response received to its activities to date, clearly indicates that there is much to be gained from this network.

The changing (technology, blended learning) and increasing (quality assurance, student diversity) demands of academic life necessitate a coordinated and cooperative approach to meeting these challenges if academics are to keep pace. A supportive improvement-oriented network like FYiMaths has the potential to provide the means by which communities of practice can form around important educational issues, yielding significant benefits for all.

2. **Ongoing network support.** The FYiMaths network is established but needs ongoing support to maintain its website and host events. The project leader should identify funding opportunities and apply for appropriate grants to support the continuing development of the network.

    a. **Annual event.** The FYiMaths network should establish a regular annual event providing a focal point for university mathematics education discussion. Connections with ACSME and AustMS should be maintained and strengthened, keeping mathematics education issues high on the national agenda.

    b. **Establishment of State nodes.** Individual network members should apply for Office for Learning and Teaching Extension grants to establish State based nodes of the network. The establishment of these nodes will build the leadership capacity of individuals and provide a local forum for ongoing discussion and development of educational innovations.

    c. **Future Review.** A review of the network should be funded three years hence. This could include revisiting the interviewees to assess the impact of the network.

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Appendix A. Certification

Certification by Deputy Vice-Chancellor (or equivalent)

I certify that all parts of the final report for this OLT grant/fellowship (remove as appropriate) provide an accurate representation of the implementation, impact and findings of the Project, and that the report is of publishable quality.

Name: Professor Richard James

……Date: 1st December 2014

Appendix B. External evaluation report by Professor Carmel McNaught.

Evaluation Report on Project LE12-2190: Building Leadership Capacity in University First Year Learning and Teaching in the Mathematical Sciences

The nature of academic networks

This project, funded by the Office for Learning and Teaching (OLT), addresses a complex issue at the centre of challenges to science, technology, engineering, and mathematics (STEM) education in universities world-wide. Like many authentic issues, the problem is an ill-defined one. Building connections, networks, capacity are all terms that are often used but rarely defined. This project (with the short title First Year in Maths, FYiMaths) has tackled the task of exploring the needs of first-year mathematics (FYM) coordinators in the context of large first-year classes, often containing students whose preparation for studying university-level mathematics is less than optimal.

In forming a model for the nature of an academic network, the notion of communities of practice (CoPs) is a useful concept that capitalizes on collegiality, and the strengths of a variety of academic perspectives. In essence, a CoP is a group of people who recognize a shared interest and purpose, and then consciously look for strategies to sustain and enhance the work they do together (Wenger, 1998). It is the element of intentionality – of conscious (and usually documented) planning and monitoring – that distinguishes a CoP from the myriad of professional and social groups that each person belongs to (Wenger, McDermott, & Snyder, 2002). Much of Wenger's work has been in the arena of business organizations. However, increasingly universities have recognized the potential for higher education to work with the ideas of communities and how they can optimally function (McNaught, 2014).

This OLT project has, within a relatively short period of time, built an effective network for FYM coordinators and others involved in teaching and managing FYM courses. It has been a privilege to have been a participant observer in this process, and I can honestly say that, in all areas, the project outcomes have exceeded my expectations.

A well-known educational theory of learning in higher education is that of the conversational framework (Laurillard, 1993, 2002) where interactions and dialogue (conversations) between teachers and students are supported by conscious internal reflections about learning by both teachers and learners – at the levels of reasoning and reconstructing (Bain et al., 1999) – which bring about improved understanding. So, in this sense, conversation implies both external focused interactions and internal reflective intra-actions.

This notion of open and focused conversation that supports deep approaches to learning (Biggs, 2003) has been extended beyond the formal teaching in universities by Bennett (2003) to be one where "conversation" is the "essential metaphor" (chapter 5) for university life. Conversation implies active and open engagement between all members of the university – both teachers and students. Bennett discussed the need to revitalize the

"virtue" of "hospitality" (chapter 3) in order to produce a university community that cares for each other and for the values of that community. Bennett focused on the role of academic leaders in promoting an interactive, conversational community at all levels of the organization.

FYiMaths has extended this notion of community beyond a particular institution to encompass the entire mathematics-education community (and indeed the whole higher-education community) in Australia. The challenges facing FYM, and the limited resourcing in many universities to effect change, have been highlighted in several important offices and public venues. I am particularly impressed by the public attention these important issues have achieved in both media and governmental venues.

Conduct and management of the FYiMaths project

The project has effectively addressed both resource issues (that have led to large FYM classes), as well as curriculum and pedagogical issues about how to strengthen opportunities for students entering a variety of STEM programs which rely on mathematical knowledge, thinking and skills.

The three desired outcomes of this project are:

Outcome 1: A First Year Mathematical Sciences Network comprised of practitioners and academic managers built through engagement with peak bodies and the broader scientific community.

Outcome 2: Increased leadership capacity built through the establishment of hands-on workshops focused on First Year Learning and Teaching in the Mathematical Sciences.

Outcome 3: Case studies and resources that describe and evaluate models for supporting First Year Learning and Teaching in the mathematical sciences.

The project members have a strong belief that all three focuses need to be addressed together – a conviction that I wholeheartedly share. This triumvirate of focuses (that have been explored and, largely, successfully enacted) positions this project as a significant contribution to mathematics education in Australia.

It has been refreshing and reaffirming to witness the passion and the dedication of the mathematics educators I have met during this project. I attended all three main events (two workshops and the National Forum), as well as several project meetings, as a 'critical friend'. I have also maintained good contact with the project leader, Dr Deborah King, and the project manager, Joann Cattlin, throughout the project. I would like to especially note that this project has benefited enormously from the relationship between a quite dynamic project leader and a scholarly, well-organized project manager. This combination has been particularly productive in FYiMaths.

The project has been very well managed. For example, the team maintained all records on project-management software (Basecamp). Given the varied and significant commitments of project team members, having something like Basecamp has been an invaluable asset for holding the project together. Initial enthusiasms can easily be eroded under the sheer weight of local responsibilities. It must be recognized that each team member had her/his

own particular pressures and competing priorities, which made it difficult for everyone to commit easily to project activities, maintain a detailed level of understanding of what was happening and what decisions needed to be made. I have observed this in many projects and know that the lead institution always drives the agenda. In FYiMaths, the Reference Group was engaged; members were supportive, and provided valuable advice and connections.

The evaluation plan

In a series of interactions, the team developed with me a comprehensive evaluation plan that is outlined in the appendix to this evaluator's report. The plan served as an ongoing reference point in the project. There were shifts in the plan but the overall approach has emphasized awareness about sources of data and how each data source can serve an evaluative function.

In the appendix, there are comments about the data associated with each of the three desired outcomes listed above. In some cases, these comments have been included in this front section of the report.

It must be recognized that there is no way that busy academic staff could mine all the data that were produced in the time-frame of the project. However, there appears to be firm interest for ongoing exploration of the evaluation-research data.

In order to support these ongoing explorations, I would like to digress a little to make some comments about the scholarship of teaching and learning (SoTL) as this aspect of OLT projects could, in many cases, be strengthened, and is noted in my final suggestion in this report.

Strengthening the network with scholarship

It is nearly 25 years since Ernest Boyer described the types of scholarship in his seminal book *Scholarship reconsidered. Priorities of the professoriate* (Boyer, 1990). These are the scholarships of:

- discovery – traditional disciplined-based research;
- integration – connections across disciplines and contexts;
- application – professional and community-oriented research; and
- teaching – where the principles of scholarly inquiry are applied to planning and implementing teaching.
-

It is taken for granted that universities are places where scholarly activities are practiced and flourish. However, over time scholarship has come to mean research in the sense of research within the confines of a traditional discipline and I believe that this notion is detrimental to understanding the nature of a scholarly institution. Universities world-wide are competitive institutions and the rewards for taking leadership roles in teaching and learning are less than striving for research outcomes in discipline-based research.

Boyer argued strongly for these four scholarships to be seen as equivalent, and not as being differentially valued in a hierarchical fashion. This is shown in Figure 1.

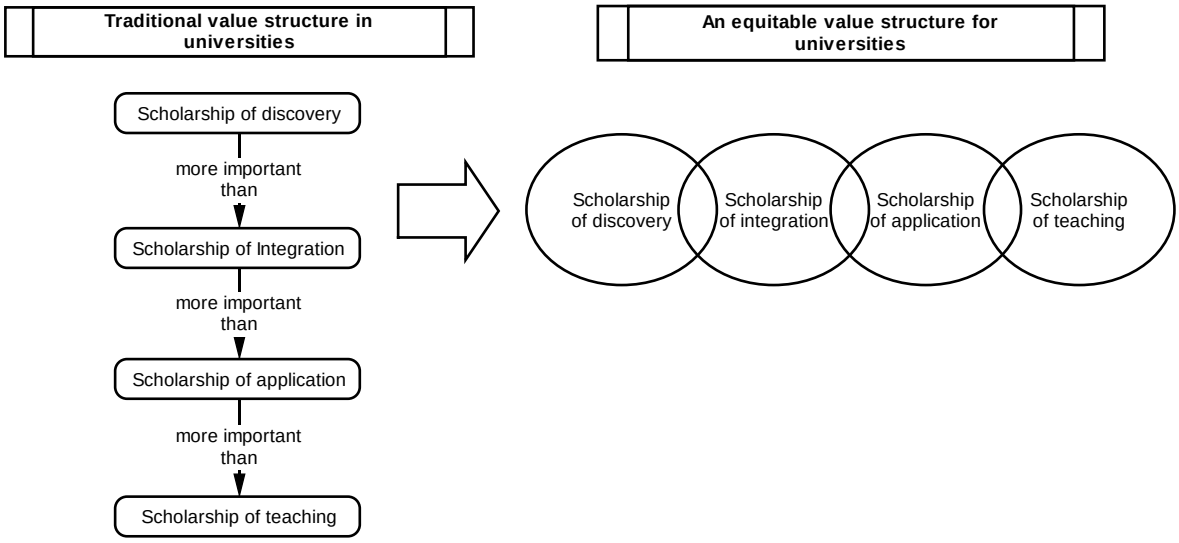

Figure 1. Boyer's scholarships in actual and idealized form.

A key point I want to make is that unless innovative educational projects – in this the development of a network – have *both* a good theoretical basis *and* good evaluation evidence, they are unlikely to make an impact on the higher-education sector. Colleagues will not invest in a network with its associated activities and accompanying resources unless they have a compelling reason to do so. This means that projects need to produce a persuasive educational rationale and a convincing set of data about the benefits to FYM teachers and the students they teach. The quality of this rationale and evidence needs to be comparable with research in other areas of scholarship.

Suggestions for OLT to consider

It is my considered opinion that the project has been conducted well and is successful in its outcomes. The findings of the project are endorsed, as are the recommendations.

However, it is important to examine a bit further how the network can be sustained and continue to grow. Drawing on my experience in this project and other OLT projects, I have three suggestions for OLT to consider:

1. *More careful scrutiny of the suggested time-lines*.
   In any project, it takes about a semester to get agreements in place and the project team gelling into a working unit. Also, once the network was established, there needed to be more time for embedding and evidence of sustainability to emerge. The project achieved a tremendous amount in the time-frame available. There was sufficient time for the project team to collect the data, organize and review events, and organize/ participate in extra activities. However, the wealth of data collected and the level of interest the project created resulted in a great deal more material, activities, liaison and communication than the team had time to adequately explore. Another workshop, which focused on building local nodes in the network and

promoting the project's findings and the *'First Year in Maths – Coordinators' Guide'* could have ensured a greater impact. In my view, this project needed to be, say, a semester longer.

2. *Building sustainability more actively into the proposal guidelines*.
   Extension grants have been designed to support ongoing work. FYiMaths is a very good example of an excellent project that is at risk without ongoing support. The network will require leadership and management to continue to exist as it is not self-sustaining at present. The website content, workshops, ongoing recruitment and liaison with members, links with other stakeholders, and attendance at key conferences requires a driver and administrator. Some of this will happen because of the enthusiasm and commitment of the project leader. However, without focused support, the normal day-to-day work takes priority, time slips and opportunities are missed.

3. *Ensuring that data analysis is well-supported, and that scholarly outputs are produced and published.*
   This project has amassed a great deal of data – both qualitative and quantitative. Analysing educational data and writing educational reports and papers is quite different to doing research in mathematics. OLT may wish to consider developing guidelines to assist projects in resourcing this vital aspect of the work. I think this project has the potential to make a significant contribution to the mathematics-education community, and this requires the production of several papers.

There is a great deal of talk about the scholarship of teaching and learning (SoTL) in the higher-education sector. OLT may wish to consider how best to ensure that maximum benefit is derived from OLT-funded projects through complete evidence of project outcomes being produced and disseminated, not only at conferences and discipline meetings but also in scholarly publication venues.

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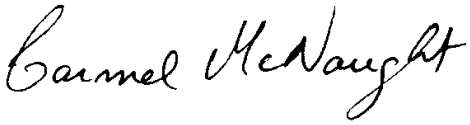


Carmel McNaught
Emeritus Professor of Learning Enhancement
The Chinese University of Hong Kong,
October 2014

Appendix to External Evaluator's Report

Annotated Evaluation Plan

Evaluation plan – Finalized in April 2013. The finalized evaluation plan is reproduced here, together with my comments (*in italics*) at the end of the project.

Broad evaluation questions:	*Comments by External Evaluator in October 2014*
What are the major achievements/ results of the project?	• *The network has been established and is well known in the Australian mathematics-education community.* • *The 'First Year in Maths – Coordinators' Guide' is an excellent outcome for the project.* • *To my mind, the most valuable contribution that the project has made is through the media and governmental attention that has been achieved. The challenges facing first-year (FY) mathematics, and the limited resourcing in many universities to effect change, have been highlighted in several important offices and public venues.*
How effective is the network?	• *At this stage it is very effective. My expectations for the project have been exceeded.* • *The next stage is crucial – with both the events and the website.*
How has the network contributed to increasing the leadership capacity of first-year coordinators?	• *This has occurred in several ways – through the events, communications (newsletters, emails, etc.), and the website itself as a resource hub and a vehicle for communication.* • *Scholarly publications are in train (journal issue; plans for papers, e.g. on the data obtained and the model for a network as a community of practice). It is really important that these scholarly papers are completed and become available for the mathematics-education community (and indeed the whole higher-education community) in Australia.*

Outcome 1: A First Year Mathematical Sciences Network comprised of practitioners and academic managers built through engagement with peak bodies and the broader scientific community.

Deliverables	**Evaluation Questions**	**Evaluation Measures**	***Comments by External Evaluator in October 2014***
1A. Initiation of communication with academics/ practitioners	To what extent did the project encourage communication with and between academics involved in teaching first-year (FY) mathematics?	1. Number and types of communication with other practitioners and academics in the field, e.g. meetings, informal discussions, sharing of information. Communications, meetings and sharing of information between team members and other academics will be noted in minutes of regular meetings. Also, record of interest in and attendance at workshop and interviews.	• *The use of Basecamp project-management software was excellent. The regular updates and reports kept the project team well informed.* • *The project website (http://fyimaths.org.au/) is clear and the members' contact list provides opportunities for contacts.* • *Messages to the network increased in frequency as the project increased with the value of providing gentle reminders about the network as well as the specific information in the posting.* • *An internal project report was produced after each of the three events that captured key messages and stimulated reflection by the project team.* • *The report on the National Forum (a key event in the project) is available on the website.*
		2. Reflection by project members each semester about how effective this communication was. A	• *Formal reflections were not gathered but the quality of internal reporting and the use of Basecamp ensured that views from each member of the project team were*

		summary of her/his reported communication, together with a brief reflective statement that includes any examples of value added by the project to communication with or between academics.	*gathered.* • *It must be recognized that each team member had their own particular pressures and competing priorities, which made it difficult for everyone to commit easily to project activities, maintain a detailed level of understanding of what was happening and what decisions needed to be made. I have observed this in many projects and know that the lead institution always drives the agenda.*
		3. Surveys of workshop attendees and network contacts list to include questions about types and extent of communication between network members.	• *The feedback from participants at the workshop events was quite detailed, indicating the value that they had gained from the event and providing considered suggestions.*
1B. Workshops 1 and 2	How were the workshops effective in raising and/or addressing issues relevant to the participants?	1. Attendance numbers, range of participants	• *Good coverage across Australia.*
		2. Feedback from participants through end-of-workshop survey	• *The feedback from participants at the workshop events was quite detailed, indicating the value that they had gained from the event and providing considered suggestions.*
		3. Reflective reports from project staff – done within 2 days of each workshop	• *Here, the project reports produced by the project manager provided the mechanism for reflection. These were disseminated and discussed on Basecamp.*

		4. Quality of data collected in each workshop and its development as resources for the project. A judgment about the value of the data might be done 3 (?) months after each workshop.	• *The website has a good range of data, information and resources.* • *There is active posting and tweeting.*
1C. Network website	How useful has the website been in developing the network?	1. Use of forums by academics, number of comments and contributions to website	• *As noted in the main report, the website has proved to be an effective mechanism for communication and feedback.* • *At this stage the website is up and running; a good number of accesses to the website occur after each email to the network.* • *The use of web logs should be considered as a measure of sustainability of the network for the future.* • *Maintaining an active website requires resourcing; I am pleased that the project team has seriously discussed options for this to occur.*
		2. Amount/ type of communication with project team initiated through website measured by tracking and counting accesses to the site and the number of email enquiries from the site.	
		3. Access logs for the website across all areas – perhaps gathered and summarized monthly (see also 1C1)	
		4. Record of improvements made to website in response to comments.	

Outcome 2: Increased leadership capacity built through the establishment of hands-on workshops focused on First Year Learning and Teaching in the Mathematical Sciences.

Deliverables	**Evaluation Questions**	**Evaluation Measures**	***Comments by External Evaluator in October 2014***
2A. Development of awareness in the main issues and concerns around leadership in teaching FY mathematics	In what ways did the workshops increase the participants' awareness of FY learning and teaching (L&T) matters?	1. Quality of discussion, documentation and dissemination of key issues identified in interviews before workshop 1.	• *The project team was kept well informed about progress of the interviews as they were being conducted. I reiterate that the use of Basecamp was a strong and valuable feature of the project.*
		2. Quality of discussion, documentation and dissemination of key issues identified in workshops. See also 1B.	• *There are clear plans to continue the network by having dedicated meetings at various events.*
2B. Improved understanding of the value of the role and responsibilities of academics teaching and managing FY mathematics	How did the workshops assist participants in understanding their role and the potential for developing their role further? Have any universities made changes to the role as a result of the project?	1. Evidence-based list of key responsibilities for the role of FY coordinator after workshop 1.	• *The 'First Year in Maths – Coordinators' Guide' is an excellent outcome for the project. It has combined an evidence-based list of key responsibilities for the role of FY coordinator with a number of case studies and this design for the publication will, I believe, increase its value to the FY mathematics community.* • *This has taken longer to produce than simply a list of key responsibilities but worth waiting for. However, because it has been produced at the end of the project, the evidence of its impact will need to be gauged over the next year or so.*
		2. Refined evidence-based list of key responsibilities for the role of FY coordinator at other times in the project. Iterations to be kept.	
		3. Best-practice case studies and resources that can be used as references by academic staff (see also outcome 3)	

2C. Provision of mentoring and professional development	What sort of mentoring and professional development occurred as a result of the workshops?	1. Number of potential mentors identified	• *Some informal progress has been made through the three events when work at various universities was shared and especially useful strategies were more widely disseminated. The work done on diagnostic testing at The University of Queensland is one example.*
		2. Iterations of a list of professional-development needs for FY coordinators that emerges throughout the project.	• *There is a good deal of useful information on the website.* • *However, to my mind, the most valuable contribution that the project has made is through the media and governmental attention that has been achieved. The challenges facing FY mathematics, and the limited resourcing in many universities to effect change, have been highlighted in several important offices and public venues. Really excellent work.*

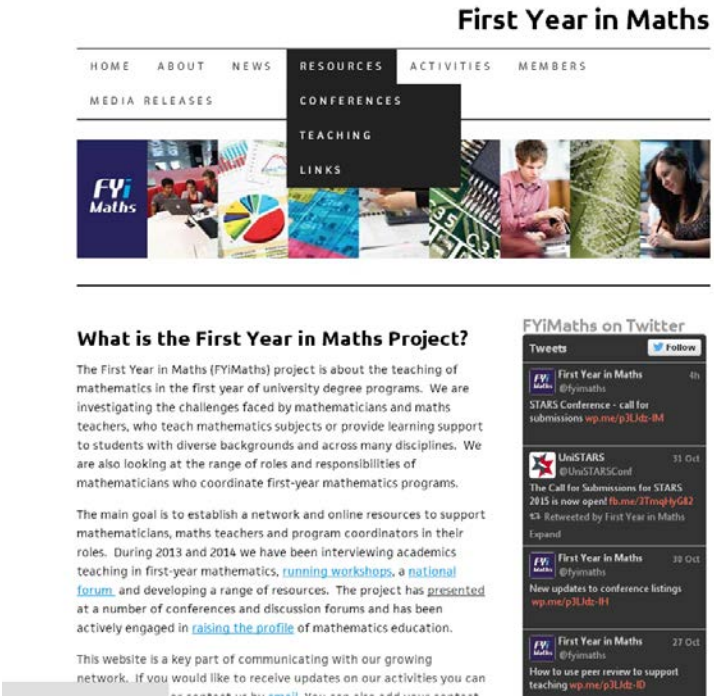
Outcome 3: Case studies and resources that describe and evaluate models for supporting First Year Learning and Teaching in the mathematical sciences.

Deliverables	**Evaluation Questions**	**Evaluation Measures**	***Comments by External Evaluator in October 2014***
3A. Case studies (including position descriptions)	Are the case studies on the website valued by FY coordinators?	1. Weblogs for this section of the website? 2. Focus group or survey of FY coordinators towards the end of the project	• *Formal surveys were conducted at the events. However, there appears to have been a constant stream of interactions that has provided feedback, ideas and suggestions. This 'organic' data is authentic and rich.* • *The 'First Year in Maths – Coordinators' Guide' is an excellent outcome for the project. It has combined an evidence-based list of key responsibilities for the role of FY coordinator with a number of case studies, and this design for the publication will, I believe, increase its value to the FY mathematics community.* • *This has taken longer to produce than simply a list of key responsibilities but worth waiting for. However, because it has been produced at*
3B. Documented roles and responsibilities	Are the list(s) of roles and responsibilities useful to staff involved in teaching FY mathematics and Heads of Schools?	1. Weblogs from this section of the website. 2. Survey of network members, Heads of Schools and workshop participants.	
3C. Database of resources relating to course content	Overall, is the database of resources on the	1. Weblogs for this section of the website?	

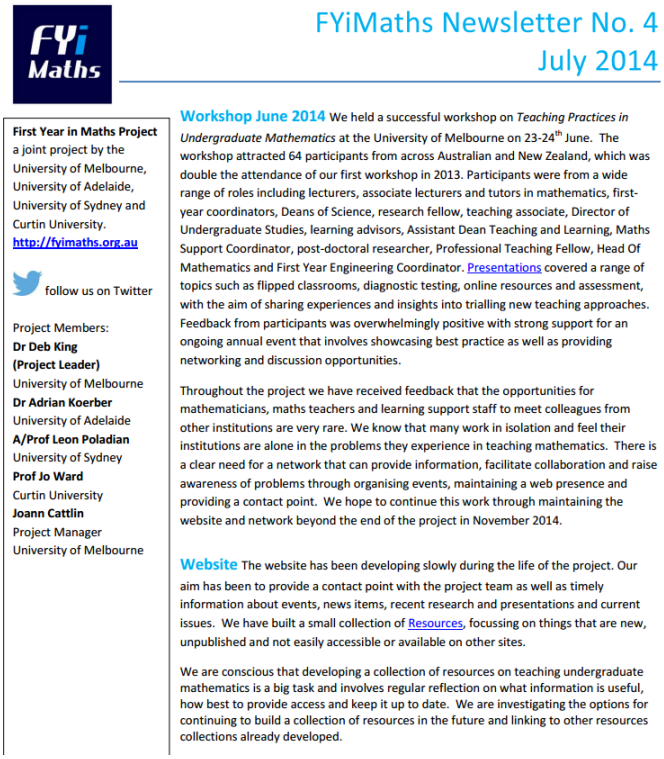
(to include course prerequisites (state-based), entry testing, assessment practices, transition programs, models for supporting FY learning, use of technology in teaching, enrolment and progression rates, etc.)	website valued by FY coordinators?	2. Focus group or survey of FY coordinators towards the end of the project	*the end of the project, the evidence of its impact will need to be gauged over the next year or so.* • *As noted earlier, the use of web logs should be considered as a measure of sustainability of the network for the future.*

Appendix C. Project promotional materials

Website



Newsletters


FYi Maths

FYiMaths Newsletter No. 4
July 2014

First Year in Maths Project
a joint project by the University of Melbourne, University of Adelaide, University of Sydney and Curtin University.
http://fyimaths.org.au

follow us on Twitter

Project Members:
Dr Deb King
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University of Melbourne
Dr Adrian Koerber
University of Adelaide
A/Prof Leon Poladian
University of Sydney
Prof Jo Ward
Curtin University
Joann Cattlin
Project Manager
University of Melbourne

Workshop June 2014 We held a successful workshop on *Teaching Practices in Undergraduate Mathematics* at the University of Melbourne on 23-24th June. The workshop attracted 64 participants from across Australian and New Zealand, which was double the attendance of our first workshop in 2013. Participants were from a wide range of roles including lecturers, associate lecturers and tutors in mathematics, first-year coordinators, Deans of Science, research fellow, teaching associate, Director of Undergraduate Studies, learning advisors, Assistant Dean Teaching and Learning, Maths Support Coordinator, post-doctoral researcher, Professional Teaching Fellow, Head Of Mathematics and First Year Engineering Coordinator. Presentations covered a range of topics such as flipped classrooms, diagnostic testing, online resources and assessment, with the aim of sharing experiences and insights into trialling new teaching approaches. Feedback from participants was overwhelmingly positive with strong support for an ongoing annual event that involves showcasing best practice as well as providing networking and discussion opportunities.

Throughout the project we have received feedback that the opportunities for mathematicians, maths teachers and learning support staff to meet colleagues from other institutions are very rare. We know that many work in isolation and feel their institutions are alone in the problems they experience in teaching mathematics. There is a clear need for a network that can provide information, facilitate collaboration and raise awareness of problems through organising events, maintaining a web presence and providing a contact point. We hope to continue this work through maintaining the website and network beyond the end of the project in November 2014.

Website The website has been developing slowly during the life of the project. Our aim has been to provide a contact point with the project team as well as timely information about events, news items, recent research and presentations and current issues. We have built a small collection of Resources, focussing on things that are new, unpublished and not easily accessible or available on other sites.

We are conscious that developing a collection of resources on teaching undergraduate mathematics is a big task and involves regular reflection on what information is useful, how best to provide access and keep it up to date. We are investigating the options for continuing to build a collection of resources in the future and linking to other resources collections already developed.

National Forum Flyer

Logo and banner

Appendix D. Dissemination

Presentations	Organisation	Date
What is the role of a First Year Mathematics Coordinator?	Higher Education Research Group, Adelaide.	Oct 2012
What is the First Year in Maths Project?	Australian Mathematical Society Conference, Sydney.	Nov 2013
FYiMaths - the challenges facing undergradudate mathematics education	Australian Council of Deans of Science, Teaching and Learning Forum, Melbourne.	Aug 2013
Building a network - Preliminary findings of the FYiMaths project	Australian Conference on Science and Mathematics Education, Canberra.	Sept 2013
First Year in Maths: the importance of leadership in first year mathematical sciences	Higher Education and Research Development Association (HERDSA) Conference, Hong Kong.	July 2014
Comparing models of first year mathematics transition and support	First Year in Higher Education Conference, Darwin.	July 2014
First Year in Maths - Building Leadership Capacity in University First Year Learning and Teaching in the Mathematical Sciences	Australian Council of Deans of Science, Teaching and Learning Forum, Melbourne.	July 2014
First Year in Maths - Building Leadership Capacity in First Year Mathematics Coordination	Australian Council of Deans of Science Annual General Meeting, Sydney.	Oct 2014
Event Organisation		**Date**
Organisation, facilitation and presenting	Workshop 1 - FYiMaths Workshop - for academics teaching first year maths, Melbourne.	June 2013
Organisation, presenting, sponsorship of session and editor of conference proceedings	Delta Conference, Kiama, NSW.	Nov 2013
Organisation, facilitation and presenting	Workshop 2 - Teaching practices in undergraduate mathematics, Melbourne.	June 2014
Organisation, facilitation and presenting	National Forum on Assumed knowledge in maths: the broad impact on tertiary STEM programs, Sydney.	Feb 2014
Organisation and presenter	ACSME Mathematics Discipline Day, Sydney.	Oct 2014
Organisation and presenter	AustMS Mathematics Convention Mathematics - Education Special Sessions, Melbourne.	Dec 2014
Organisation and presenter	Joint AAMT/ACDS Joint Conference, Connections and Continuity, Canberra.	Dec 2014
Invitations and Visits		**Date**
Four visits from mathematics educators to Project Leader at University of Melbourne to explore tutorial program.		2014
Two invitations to the Project leader to visit and speak at another institution on tutorial programs.		2014

Articles Published

- King, D. & Cattlin, J. (2014). Forum on assumed knowledge in maths. *Australian Mathematical Society Gazette*. 41 (3).

- King, D. & Cattlin, J. (2014). Time to change the maths message: what does 'assumed knowledge' really mean for students? *HERDSA News.* 36 (1).

- King, D. (2014). Maths is important but should it be compulsory? (2014, February 10) The Conversation. Retrieved from http://theconversation.com/maths-is-important-but-should-it-be-compulsory-22050.

- King, D. & Cattlin, J. (2015) (submitted). Building a network and finding a community of practice for academics teaching in undergraduate mathematics. In J. McDonald & A. Cater-Steel (Eds), *Communities of Practice – Facilitating Social Learning in Higher Education.* Netherlands: Springer.

Media coverage

- Unis can fail to lay maths requirements on the table, (27 August, 2014). The Australian, Higher Education.

- Time to act over HSC students' weak maths, (14 February, 2014). The Sydney Morning Herald.

- Spell out courses' maths demands (17 September, 2014). The Australian, Higher Education.

- Promoting the importance of maths. (2014 April 14) Inspiring Australia. Retrieved from http://sydney.edu.au/science/outreach/inspiring/news/adam-spencer.shtml

Journal

- Project team guest editing special issue of International Journal of Innovation in Science and Mathematics Education on theme of Assumed Knowledge in Maths: its broad impact on tertiary STEM programs. Expected publication December 2014.