**MatRIC** Centre for Research, Innovation and Coordination of Mathematics Teaching

# Annual Report for 2017

# Contents

## 1. Abstract

2017 was the fourth year of MatRICs activity and attention has continued to be focused on addressing the plan set out in the Centre description formulated in 2013. Changes to this description have been outlined in previous annual reports. In 2017, MatRIC has, as set out in the report for 2016, additionally focused on the development of student partnerships. In the context of the original plan, and the additional goals taken on since the plan was made, 2017 has been a highly successful year and the evidence of meeting the key *process* goals of community and network building is apparent through MatRIC's events and actions. A full programme of events has been achieved, these are set out below. Organising the events and activities is demanding and MatRIC depends upon a large team of committed and enthusiastic leaders and coordinators. The events and activities described in the annual report are the context for networking and sharing experience of high quality teaching, innovation, and research evidence.
The achievements provide a solid foundation for developments set out in the Phase Two Action Plan, the preparation of which was a significant achievement during 2017; the process engaged a large number of local (UiA), national and international stakeholders.

## 2. Results compared to the application and plans

**MatRIC's accomplishments compared to the planned and completed activities in the period, and its impacts.**

**a. Activities/projects that have been conducted and what are the effects and results of these?**

**i. Activities/projects that have had the desired results?**

### Annual conference

The conference is an important event in MatRIC's programme. It contributes to developing MatRIC's national profile. It creates an important arena for networking. It provides a showcase for examples of international and national excellence in university mathematics education. Increasingly, it provides a showcase for MatRIC's and others' achievements at UiA and nationally.

The conference was held at Gardermoen, Oslo airport. The keynote speakers were Professor Chris Budd (University of Bath), Professor Chris Rasmussen (San Diego State University), Professor Berit Kjeldstad (NTNU), and Professor Chris Sangwin (Edinburgh University). There were about 70 participants. Responses to the evaluation questionnaire completed after the conference confirmed impressions during the event that it was the most successful conference to date. Credit must be given to the Programme Committee (Inger Johanne Knutson, Ragnhild Johanne Rensaa (UiT), Helmer Aslaksen (UiO) and Lillian Egelandsaa).

### MatRIC Networks

MatRIC's networks focus on innovation in teaching and learning mathematics (Computer Aided Assessment, Visualisation and Simulation, Mathematical Modelling, and Video), and mathematics in different programmes of study (Teacher Education, Engineering, Economics, Natural Sciences). The latter category is underdeveloped, and their establishment is one of the challenges facing MatRIC during the remainder of Phase 1 and Phase 2.

Active networks are a key strategy for sharing and stimulating better practice in HE mathematics education – through didactical innovation and (to be developed) course and programme design and implementation. Networks also contribute to dissemination and eventual sustainability of MatRIC's vision and activity.

### Computer aided assessment

This can be presented as an exemplar network. The network embraces HE mathematics teachers from Norway and across Europe. We hope to combine with a Finnish network during 2018. The coordinator of MatRIC's CAA network (Morten Brekke) has been instrumental in bringing the group together and he remains active in keeping the connections with other institutions alive. Several presentations at the MatRIC conference, 2017, came from participants within this network.

There was a network meeting following the conference in October, with 18 participants from Norway, UK and Holland. The next meeting is planned for April 2018 in which three members of the Finnish network (https://abacus.aalto.fi/ ) will participate.

## Simulation and visualisation

The foundation for this network is the dedicated endeavour of a small number of enthusiasts, especially Per Henrik Hogstad (Network Coordinator). During 2017 two significant events have occurred that provide grounds for hope that the kernel of a Norwegian network now exists. First, encounters that happened at the MatRIC conference have led to some collaboration across institutions. An intention of this collaboration is to develop the user interface of the visualization and simulation program SimReal, to provide a friendlier entry point for teachers and students new to the software (collaboration with University College of Molde). Second is collaboration with one of the most recently awarded Centres for Excellence, Centre for Computing in Science Education (CCSE) at the University of Oslo. We hope to arrange a joint MatRIC/CCSE workshop in the autumn 2018 (University of Oslo (CCSE), FFI (Norwegian Defence Research Establishment) and University College of Molde want to contribute in this workshop). It was hoped to hold this workshop during 2017, but circumstances did not allow this to happen.

SimReal is now extended to include programming/coding in JavaScript, Jupyter, Python and Matlab, this will hopefully increase the possibility for collaboration.

One of MatRIC's PhD fellows is researching visualization and simulation in mathematics education.

## Video.

This has focused on the production of MatRIC TV, with a production group from UiO, HiOA, HSN, NTNU. About 70 videos have been published with a similar number waiting for final editorial control. The videos were presented at the MNT conference 30-31 March by two members of the production group. Most interest within the network is focused on how video may be used effectively in teaching and learning and interest on so called 'flipped classroom' approaches (and variations on this theme). Two of MatRIC's PhD fellows are researching teaching and learning with this approach.

## Mathematical modelling.

Efforts have continued to find partners in industry/business and enterprises to provide real, challenging problems for our mathematics students to work. So far, we have not met with success. There appear to be several reasons for this: no culture of this type of collaboration, reluctance of for-profit enterprises to open up to (perceived) unprofitable partnership, mathematical modelling is undertaken by remote research consultants, and lack of time or interest. The coordinator of this group (Yuriy Rogovchenko) has been involved in many meetings and discussions, so far with no success. The coordinator is pursuing two proposals for external R&D funding: Eurasia 2017 three-year funding application CPEA-LT-2017/10011 "Personalized Innovative Technologies for Mathematical Competence of Students" (PITMaCS) with main partners UiA and Boris Grinchenko Kyiv University. Also, a revised proposal (2017 proposal was unsuccessful) for Erasmus+ funding for the project PLATINUM (Partnership for Learning and Teaching in University Mathematics) in spring 2018.

Two of MatRIC's PhD fellows are working in this area, their focus is mathematical modelling in biology and pursued in collaboration with bioCEED SFU at UiB.

## Teacher education

A workshop was held on October 18 with guest presenters Professor Mike Askew (University of Witwatersrand, Johannesburg) and Hanan Mohamed Farouk Abdelrahman (Holmboepris winner 2017). This was well attended with about 70 participants. The coordinator of this network stands down at the end of 2017 and we thank Claire V. Berg for her contribution and support. The appointment of a replacement is a task for early 2018 – attempts so far have not been successful.

There is one MatRIC PhD fellow who has a focus within mathematics teacher education.

## Open Lecture

MatRIC's 'Open Lecture' is primarily aimed at incoming students, although invitations are sent to nearby upper secondary schools. The purpose of the lecture is to get MatRIC into students' consciousness, so they will recognize MatRIC as behind the Drop-in support centres, efforts to develop student teaching assistants, and actions promoting students as partners in teaching and learning. Further, the lectures are aimed at stimulating interest and motivating engagement in mathematics for its own sake.

The 2017 Open Lecture was presented by Vibeke Gwendoline Fængsrud on 31 August. The lecture was given on both campuses. Both were very well attended, especially at Grimstad, the audience filled 'Bluebox'. This year's lecture focused on successful study skills for learning mathematics.

## Drop in mathematics support

Drop-in support has continued throughout 2017 on both UiA campuses. Feedback from students who use the provision is positive and it is clear the Drop in support serves a need. The leaders of the provision (Svitlana Rogovchenko in Grimstad and Anne Berit Fuglestad in Kristiansand) will continue in their efforts to maintain and promote drop-in support.

## Students as Partners

Several actions were taken during the summer and autumn to support students studying mathematics in their first semester within the economics programme.

### Students as Partners Summer Institute – Change Institute, 8-11 May, 2017. McMaster University Hamilton Ontario.

MatRIC was represented with a team of six, three staff, three students: Astrid Birgitte Eggen (Vice Rector & Chair of MatRIC Management Board), Lillian Egelandsaa (MatRIC Project Manager), Simon Goodchild (MatRIC Director), Kai Steffen Østensen (STA Leder), Helene Vedal (STA Nestleder) and Kristian Bakken (STA Fagpolitisk ansvarlig). This was a very valuable workshop in which we worked together as a group for three and a half days, guided through a process of developing ideas by a team of facilitators. Our chosen focus was how MatRIC will work with students as partners to support teaching and learning on the mathematics for economics programme. The workshop and MatRIC's focus occurs alongside SG's participation in discussions at UiA's School of Business and Law about changes to bachelor level programmes, and discussions with colleagues in the Department of Mathematical Sciences about students' performance in the mathematics for economics courses.

### Student teaching assistants

MatRIC piloted a two-day, residential training camp for student teaching assistants, organized by Prof. Thomas Gjesteland and Lillian Egelandsaa. Contributions were also made by Mathematics teachers Kirsten Bjørkestøl and Rolf T. Nossum, Director of UiA's Centre for educational development Gunnar Horn, and MatRIC Director Simon Goodchild. There were 19 student participants, who continued through the semester as mathematics teaching assistants for engineering (with Thomas Gjesteland) and economics (with Rolf Nossum and Kirsten Bjørkestøl). The training camp covered such issues as mathematics didactics, communication skills, and approaches to learning and doing mathematics. The training camp was well received by all participants and we hope this will become a regular feature in MatRIC's programme.

Following the camp two teams of student teaching assistants, one for engineering and one for economics were formed. The STAs were assigned teaching and support tasks, working with students in their first semester mathematics courses. The teams met on a weekly basis with the course teachers. The major goal for this was to try to reduce the failure rate from the first semester mathematics courses, which over many years have proved extremely resistant to attempts at improvement. Early signs are that this effort has achieved the hoped-for success with economics students, but not so with the engineering students. This contrast provides the opportunity to look deeply into reasons for success.

There are cultural and institutional issues that MatRIC must contend with – as recommended by the panel undertaking MatRIC's interim evaluation.

Students as partners in education means far more than a few internships or the development of student teaching assistants. The goal is to engage all students as partners in teaching, learning and assessment. Such engagement may help to address the challenges listed above. Achieving the goal will entail the active collaboration of teachers and students – stimulating this collaboration is one of several challenges MatRIC faces.

### Summer internships

Three summer internships: (i) developing an on-line self-assessment instrument, so students could evaluate their need for additional support; (ii) developing an on-line (SurveyXact) instrument to complement the regular course

evaluation and acquire more information about students' experience with MatRIC's support; (iii) a review of mathematics applications within economics studied at undergraduate level to help teachers make the mathematics taught relevant to the economics programme. These pilot internships were successful, with lessons to be learned for the future. Two were reported briefly at the MatRIC conference. These internships were supported by a modest grant from the UiA 'Digital University' project.

### MatRIC research group

MatRIC's actions are directed towards developing a sustainable research base for research in university mathematics education, and creating knowledge about teaching and learning mathematics in both traditional and innovative settings. The goal is to inform mathematics teaching and learning in Norwegian (and international) HE with high quality, scientifically sound, cutting edge research.

Barbara Jaworski coordinates the MatRIC research group. In this role she has evaluated proposals for five MatRIC small research grants (one pending). Also there have been two research seminars/forums arranged:

- 14 August 2017 with Professor Emerita Norma Presmeg (Mathematics Department, Illinois State University) and Professor Jeppe Skott (Linnaeus University, Sweden).
- 30 November-1 December Research forum, seminar (MatRIC PhD fellow Helge Fredriksen), and supervisions.
- Also, with support from Martin Carlsen, Olov Viirman organized a two day seminar 26-27 October, with Professor Anna Sfard (University of Haifa)
- Said Hadjerrouit organized a seminar 20 November with Professor Emerita Michelle Artigue (Université Paris Diderot - Paris 7)

The above MatRIC supported events took place within and complementary to the regular programme of the UiA Mathematics Education Research Group.

*PhD fellows*: Two new PhD fellows joined MatRIC in September Ida Landgärds who is researching mathematics teaching and learning in the economics programme, and Floridona Tetaj who is researching mathematical modelling in biology education (continuing the collaboration with bioCEED). There are now 8 MatRIC PhD fellows: (Ninni Marie Hogstad, Helge Fredriksen, Yannis Liakos, Shaista Kanwal, Henrik Kjelsrud, Eivind Hillesund & and the new appointments above).

### Teaching induction course

The teaching course is presented as a collaboration between MatRIC and NTNU. The goals of the course are:

- Develop a HE mathematics didactics course that will complement the regular HE pedagogy courses (UNIPED), and contribute to the development of 'excellent university teachers' ("merittering").
- Stimulate interest in teaching, teaching development and innovation in education, especially with new entrants to the profession.
- Draw HE mathematics teachers into professional networks that share an interest in the quality of teaching and learning mathematics.

The first session of the course took place at Gardermoen on 26-27 September with six participants, these come from UiA, NMBU(2), UiB, UiT, UiOA. The course is led by Frode Rønning (NTNU), Helmer Aslaksen (UiO) and Simon Goodchild. In the first session there were presentations by Professor Emerita Lisa Lorentzen (NTNU), André Heck (University of Amsterdam) and Burkhard Alpers (Aalen University).

The second session which focused on critical viewing and discussion of students' self-produced mathematics videos took place at UiO, Blindern on 3 November.

The third session will be held in Kristiansand, 9-10 April, with presentations from Professor Chris Rasmussen and Professor Chris Sangwin. It will also include reports from participants' action research projects. There will be a fourth session in June, the date to be fixed.

## Visiting researchers/experts

Marilyn Carlson from Arizona State University made a presentation "*Implementing and Studying Professional Development for Student Teaching Assistants*" at the Department of Mathematical Sciences seminar in Copenhagen on 7 June.

**ii. Activities/projects that have not had the desired results and what are the lessons to be learnt from this?**

MatRIC's plan for phase 1 focused on process goals, these processes – conferences, workshops, networks are the means to establish a learning community of HE mathematics teachers in Norway. The developmental outcomes desired are then expected to emerge from teachers sharing experiences of innovation. MatRIC injects 'fresh blood' into the community through the inclusion of international voices, leading and stimulating research and development activities. The growing engagement in, and enthusiasm for MatRIC's programme is evidence that the strategy is proving successful.

**iii. Activities/projects that have not been carried out? Why have they not been carried out and what are the consequences?**

See above the challenges faced by the Mathematical Modelling network, also that a workshop for visualisation and simulation was not held as planned.

**b. MatRIC's engagement with dissemination and how the centre has involved others in its activities/projects.**

A detailed description of MatRIC's dissemination strategy was included in the annual report for 2016, this is reproduced in the appendix pages 37-39. Consistent with the original proposal for MatRIC dissemination has been directed at achieving the networking and process goals of the Centre. MatRIC's dissemination strategy has been to engage HE mathematics teachers in Norway, and stimulate an international dialogue that will support and improve the mathematics education of Norwegian students through sharing experience of innovation and research. In addition to the MatRIC led events outlined above, and MatRIC's web pages and Newsletter, MatRIC has been involved in the following international and national events.

### CERME 10 Conference, Dublin 01-05 February, 2017

Congress of European Researchers in Mathematics Education. Several from MatRIC participated in either the university mathematics education research working group, or the mathematical modelling research group (Helge Fredriksen, Simon Goodchild, Ninni Marie Hogstad, Yannis Liakos, Yuriy Rogovchenko, Olov Viirman).

### MNT Conference, Oslo 30-31 March, 2017

MatRIC was represented at the MNT Conference with a stand and literature to take away and a short video. All five MNT centres of excellence (MatRIC, bioCEED, CCSE, Engage, ExCiTe) were presented in plenary session. There were also research and innovation reports relating to MatRIC's activity. The documents prepared for this event will also be used by the MatRIC Ambassadors, together with a compilation of articles about MatRIC that have appeared in NOKUT's 'SFU Magasine'.

### NORMA Conference, Stockholm 30 May-2 June 2017

The Eighth Nordic Conference on Mathematics Education. This conference meets on a three-yearly cycle. It is the major mathematics education conference for the Nordic region. MatRIC (Frode Rønning and SG) organized a symposium with four research reports and an expert reactor. There were, in addition to the symposium three papers that reported research supported by MatRIC. Other MatRIC presentations were made by Yannis Liakos

### ICTMA 18, Cape Town, 23-28 July 2017.

The International Community of Teachers of Mathematical Modelling and Applications. Yuriy Rogovchenko presented two research reports from the Mathematical Modelling Network.

### November Conference, Trondheim 28-29 November, 2017 (annual conference of the Norwegian Centre for Mathematics Education, NSMO)

Frode Rønning and Simon Goodchild, with two students from NTNU led two workshops for upper secondary teachers, the workshops focused on symbols, expressions and meanings in higher mathematics.

### NOMAD (Nordic Studies in Mathematics Education) MatRIC proposed a thematic issue of the journal, focusing on higher education. The issue was published, December 2017 (Volume 22, number 4), editors are Frode Rønning, Simon Goodchild and Barbara Jaworski. An open call for papers was announced, 50% of the included papers originate from MatRIC's activity.

## 3. Aims of the SFU initiative: R&D-based education, integrated models and student engagement

**a. MatRIC works with student-active learning methods in connection with R&D-based education**

Mathematics teaching is a very conservative practice; for many university teachers, exposition supported by chalk and chalkboard are argued to be the best and only technologies appropriate for teaching higher mathematics. Very large mixed classes in universities, especially in the early years of study, where a group of several hundred students composed from several different programmes of study are reinforcing the opinions of the most conservative, and leading those teachers more open to change to seek alternative approaches that will enhance student participation, engagement, motivation, enjoyment, learning and performance. MatRIC seeks to work with the latter to develop examples of excellent and effective practice that will convince the former group.

An additional challenge faced by MatRIC is that traditional methods of assessment in mathematics tend to favour the development of instrumental process skills, which are quickly learned and as quickly forgotten after an examination. Deeper conceptual understanding is more difficult and generally costs much more to assess. MatRIC seeks to support students' fluency in basic processes *and* their underlying conceptual understanding. We seek effective measures for the effectiveness of MatRIC actions in this respect. Related to this is the recognised importance of effective feedback to students, this too is challenging given the very large classes and the use of student assistants with minimal if any didactical training for the task. MatRIC is taking on this challenge through the CAA network and the development of training programmes for student teaching assistants.

MatRIC is embedded in a Department of Mathematical Sciences, but serves within the university mathematics teaching across the Faculty of Engineering and Science. Further, MatRIC's mission is to be a resource for excellence for mathematics teachers working in higher education institutions throughout Norway. MatRIC's actions are in support of pilot projects that can be demonstrated to be effective and thus adopted by teachers and supported as regular activities by their respective departments.

During 2017, MatRIC has promoted student engagement in research and development based education in several ways including summer internships and the development of student teaching assistants' didactical competencies.

Radical changes to teaching and learning approaches must be taken with care. An approach that has been taken by one teacher in one context and that has proved to be successful will not necessarily work in another context by another teacher. Innovation requires careful preparation, by and of the teacher and the resources that are needed. The MatRIC coordinator of the video production and computer aided assessment networks is using his long and deep experience of using technology in his practice to transform the teaching and learning approach in the mathematics course for students on the electrical engineering programme at UiA. This has been described briefly within the reports from these networks above. Feedback from students and performance in the examinations suggest the innovation is highly successful.

**Added value of R&D-based education when it comes to learning outcomes and relevance.**
It is difficult to point to valid and reliable performance indicators, and it is safer to doubt the trustworthiness of superficial measures. Learning experiences (and outcomes) need to be explored through well-structured research that probes deeply into students' meanings. Student satisfaction with teaching and learning is a useful indicator, but it is necessary to exert a lot of effort to encourage students to respond to surveys.

**MatRIC's operation and structure set to develop R&D-based education and student engagement.**

Through Centre events – conferences, workshops, etc. that provide opportunities for sharing experience. Also through the provision of small research and development grants that encourage mathematics teachers to be innovative – and systematically explore their practice.

**b. MatRIC's development and enhancement of integrated models affected the students' learning outcomes?**

Improved performance, better progression, higher retention and lower drop-out are the student's learning outcomes that we seek, in addition to improved motivation and attitudes towards studying mathematics. However, given the challenges outlined in the foregoing it is very difficult to attribute changes in these indicators directly to MatRIC actions. Further, MatRIC's engagement in the provision of mathematics support through the Drop-in centres can easily mask the impact of the R&D based education that engages students as partners in teaching and learning which lie at the core of MatRIC's activity.

MatRIC supported a student group developing an on-line learning resource for programming in mathematics. Their work gained the attention of mathematics teachers – for numerical methods. Moreover, the MatRIC support

provided the students with a platform for seeking a grant from the Research Council of Norway. They were awarded one-million kroner and have now set up their own company located in a technology innovation centre in Oslo.

MatRIC's approach is to support research that explores the nature of teaching and learning within different settings, innovative and so called 'traditional'. Eight PhD fellows and a Post-Doctoral Research fellow are engaged in researching university mathematics education, we hope to expand this group. MatRIC seeks a sound scientific basis for the claims made about improvements in student outcomes.

## 4. Plan for 2018

**Adjustments of the Centre's plans In light of the results and evaluation of 2017**

### Plans for the future include:

Implementation of the Phase 2 Action Plan prepared for the interim evaluation (attached) including the following:

- Appointment of co-Director
- Appointment of coordinator for teacher education network
- Appointment of MatRIC researcher (to replace Post-Doc Researcher, Olov Viirman)
- Appointment of institutional contacts – to improve MatRIC's communication with HE mathematics teachers throughout Norway.
- Appointment of convenors for programme focused networks (economics, engineering, life sciences, etc.)

For other plans for 2018, please refer to the Action Plan for Phase 2 that was prepared as part of the interim evaluation.

### Research Group Plans

- Research symposium in Athens, May 2018. This will be in collaboration with the Mathematics Education Research Group at University of Athens (Professor Despina Potari). The potential value for MatRIC is to make stronger bonds within the MatRIC research community through this international visit.
- EU H2020 Innovative Training Network proposal. MatRIC has been involved with unsuccessful proposals for the past two years and the group plans a third attempt (deadline 17 January). Universities in France, Germany, Denmark and Spain are also part of the group. UiA is supporting the development of the proposal.
- EU H2020 Erasmus+ proposal led by Yuriy Rogovchenko.
- NTNU are in the process of appointing two PhD fellows to research university mathematics education. We hope to include these within the MatRIC research group.

### Conference 2018

Looking forward to 2018 we are considering a conference themed on 'student partnership' in which one part focuses on students as partners in learning. This could take place in September (to avoid clashing with the start of the autumn semester in the UK), and possibly in Oslo or Bergen, so that if we invite students from other countries the location makes it easier to give them a taste of the 'traditional Norway' – mountains and fjords.

### Workshops & symposia

Computer Aided Assessment Workshop in Kristiansand April 11 &12 2018.
Visualisation and Simulation Workshop (we hope in collaboration with CCSE) autumn 2018.

### International Conference

April 2018, MatRIC will be host to the conference of International Network for Didactics Research in University Mathematics.

## Attachments to the report:

### o Personnel

The salary costs in MatRIC can be seen in the financial statements attached to this report. In 2016 these persons have contributed to the work of MatRIC (proportion of full-time position shown as % in parentheses):

- Simon Goodchild, Centre Leader, (50%).
- Lillian Egelandsaa, Project Manager, (70%)
- Morten Brekke, Coordinator for the video and digital assessment network, (20%).
- Per Henrik Hogstad, Coordinator for the Simulation and visualization network, (20%).
- Yuriy Rogovchenko, Coordinator for the Modelling network, (20%).
- Claire Vaugelade Berg, Coordinator for the Teacher Education network, (20%).
- Anne Berit Fuglestad, Leader MatRIC Drop-in Mathematics Support, Kristiansand (20%)
- Svitlana Rogovchenko, Leader MatRIC Drop-in Mathematics Support Grimstad (20%)
- Elisabeth Rasmussen, Administrative support (10%)
- Ninni Marie Hogstad, Conference support (20% from 01 May 2016)
- Post-doctoral Research Fellow Olov Viirman, (100%). Completed July 2017
- Personnel working in the Drop in Centre – hourly payment.
- PHD research fellows in MatRIC (these are not paid from the MatRIC budget):
    - Ninni Marie Hogstad started August 2014
    - John Liakos, started August 2015
    - Helge Fredriksen, started August 2015
    - Shaista Kanwal – August 2016
    - Henrik Aadland Kjelsrud – August 2016
    - Eivind Rudjord Hillesund – January 2017
    - Ida Landgärds – September 2017
    - Floridona Tetaj – August 2017

In addition to this some more colleagues have been paid on an hourly rate.

### o Financial accounts* 31 December 2017

| **Summary** | |
|---|---|
| **Brought Forward** | **1,831,516** |
| + Funds from NOKUT | 4,000,000 |
| + Funds from UIA | 3,000,000 |
| + Funds from Faculty TEKREAL | 1,000,000 |
| - Costs (see details below) | 6,264,231 |
| **Carried Forward** | **3,567,284** |

| **Detailed costs** | |
|---|---|
| **Aggregated amounts** | **Year** |
| **Category** | **2017** |
| **Purchases** | 35,786 |
| **Personell** | 4,399,697 |
| **Travel** | 1,356,704 |
| **Diverse** | 469,876 |
| **Internal costs** | 2,168 |
| **Total** | **6,264,231** |

Notes:

1) From 2017 MatRIC has not paid ‘indirect costs’ for UiA employees, thus reducing salary costs.

2) MatRIC has not paid the salary for the Post-Doc position since August 2017, the funding now runs one year in advance of the position (ie. there is one-year of funding in the amount carried forward to 2018).
3) As a result of the interim evaluation and preparation of a phase 2 action plan, several planned network events did not take place during 2017.
4) The accounts above do not include the costs of 8 PhD fellowships now connected to MatRIC, these fellowships are supported by KD stipends given to UiA.

### o Publications


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Fredriksen, H. (2017). Utilizing commognition as a framework for exploring engineering students´ participation in mathematics discourse in a Flipped Classroom environment. Eighth Nordic Conference on Mathematics Education, NORMA 17 will take place in Stockholm, Sweden, the 30 May – 2 June 2017.

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Hogstad, N. M., & Isabwe, G. M. N. (2017). A digital tool for applying integrals in a kinematic simulation: A perspective on instrumental genesis, epistemic value and semiotic potential. In T. Dooley, & G. Gueudet (Eds.), Proceedings of the Tenth Congress of the European Society for Research in Mathematics Education. Pp. 2089-

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o Action Plan for Phase 2 (next page)

**MatRIC** Centre for Research, Innovation and Coordination of Mathematics Teaching

Action plan for a second phase of Centre funding 2019-2023.

*(Note: Figures are included in the appendix)*

**Abbreviations**

Many of the abbreviations used in this action plan are acronyms of Norwegian titles, the English titles are listed below and often bear little if any relationship to the acronym.

| | |
|---|---|
| CoP | Community of Practice |
| CPT | Community of Practice Theory |
| HE | Higher Education |
| HEI | Higher Education Institution |
| INDRUM | International Network for Didactics Research in University Mathematics |
| KD | Ministry of Education |
| KHDM | Centre for Higher Mathematics Education (Universities of Hannover, Kassel & Paderborn). |
| M | Mathematician, mathematics researcher |
| ME | Mathematics Education |
| MER | Mathematics Education Researchers |
| MNT | equivalent of STEM, Science, Technology, Engineering and Mathematics. |
| MT | Mathematics Teacher |
| NFR | Research Council of Norway |
| NMR | Norwegian Mathematics Council |
| NOKUT | Norwegian Agency for Quality Assurance in Education |
| NSMO | National Centre for Mathematics Education |
| NTNU | Norwegian University of Science and Technology |
| PIC-math | Preparation for Industrial Careers in Mathematics |
| PULS | Centre for Educational Development (UiA) |
| RAISE | Researching, Advancing and Inspiring Student Engagement - Network |
| R&D | Research and Development |
| RUME | Special Interest Group of the MAA on Research in Undergraduate Mathematics Education |
| SFU | Centre for Excellence in Education |
| ISISP | International Summer Institute on Students as Partners in Learning and Teaching |
| STA | Student Teaching Assistant |
| UHR | Norwegian Association of Higher Education Institutions |
| UD | Norwegian Directorate for Education and Training |
| UiA | University of Agder |

## 1. Introduction

This action plan is the outcome of meetings involving a comprehensive range of stakeholder representatives at institutional, national and international levels. Discussions have focused on the challenges and suggestions articulated in the "SFU Interim Evaluation, Report following site visit." The plan builds on MatRIC's achievements gained over the initial three and a half years of activity. This document sets out to communicate: MatRIC's vision; focus and connectedness in MatRIC's goals and strategy; security of leadership; and MatRIC's strategic role within the University of Agder (UiA), national and international educational contexts.

## 2. MatRIC's Vision

Students' experiences of learning mathematics are central in MatRIC's vision. Figure 1 (see appendix) illustrates MatRIC's focus. Performance in mathematics in higher education continues to be a cause of national concern. Securing durable improvements in educational provision is a multi-layered task including the teaching and the contexts and systems in which learning is intended. Thus, MatRIC has a role in challenging teachers and supporting change in teaching, curriculum implementations and structures. However, such change takes time, and in the present MatRIC is aware of the on-going needs of students, we therefore have a concurrent role to demonstrate how the difficulties students experience today can be ameliorated through learning support. This dual role, amelioration in the present and challenge to change for a better future is worked into a single theoretically coherent vision. MatRIC is a resource, a change agent, a competence broker, a provocateur for action, and a provider of evidence based knowledge.

MatRIC's vision is therefore: *Students enjoying transformed and improved learning experiences of mathematics in higher education.*

The characterisation '*transformed and improved learning experiences*' entails:

- Students as partners in teaching, learning and assessment.
- Research and development based (informed and enriched) education.
- Appropriate and timely learning support, and opportunities for constructive feedback about performance and the development of mathematical competencies.
- Teaching that ignites interest and enthusiasm for mathematics.
- Teaching that exposes the relevance and value of the mathematics learned in whatever discipline it is studied thereby motivating engagement in learning.
- Varied approaches to teaching, learning and assessment and accommodation to learners' individual needs and learning styles.
- Effective use of technology and other resources for learning and teaching.
- Courses integrated within the programmes of study to which they contribute.
- Courses designed to accommodate variation amongst learners, such as the prior knowledge they bring to their studies.
- Structures that enable efficient and effective learning opportunities.

MatRIC is committed to working towards this vision within UiA with Norwegian mathematics teachers (MTs) and higher education institutions (HEIs), and with international partners.

As a change agent, MatRIC faces challenges in addition to those outlined above. MatRIC has adopted a national role to spread and develop excellence in mathematics teaching across Norwegian HEIs. MatRIC has gained recognition for its national contribution during Phase 1 and will use its position in Phase 2 to influence policy and practice at institutional, programme and course levels. MatRIC's national actions will motivate, encourage and facilitate collaboration amongst the HE mathematics teaching and MER communities, and bind these into an authoritative and respected body of recognised expertise in mathematics education. MatRIC can call upon experience of mathematics teaching development at school level, but because of the added complexity of mathematics education at higher education it is not a simple matter of transferring knowledge from one arena (school level) to another arena (higher education). MatRIC is at the cutting edge of knowledge creation in the field, and within Norway MatRIC is opening up and leading a new field of inquiry: mathematics teaching development at higher education.

## 3. Operationalisation

MatRIC is operationalised within community of practice theory (CPT) in which the operative terms are: *enterprise,*

*engagement, repertoire, participation, belonging and identity*. To accommodate the developmental purpose of MatRIC, CPT is expanded to include individual's agency to change practice, and here the operant terms are *critical alignment* and *systematic inquiry (research)*. MatRIC enters an arena comprising three intersecting practices: students' practice, teachers' practice and mathematics education researchers' (MERs) practice. MatRIC acts as a broker between these three practices. MatRIC's vision entails on the one hand supporting students to move along a trajectory from being peripheral participants (as receivers) to full active contributing participants and agents in their HE, and on the other hand, MatRIC is an agent of change and transformation, uniting the separate practices by promoting students as co-creators of knowledge and co-producers of education, and innovative R&D based education.

The intended outcomes expected to arise from MatRIC's actions will be measured in terms of: (1) students' satisfaction and self-reports of their engagement with the educational and knowledge creation processes; (2) teachers' participation in MatRIC actions (events, small research grants, teaching development trials, innovative teaching) and networks, and changing their practice as a result of engaging with MatRIC; (3) production, dissemination and influence of reports arising from research and development activity promoted and facilitated by MatRIC; in CPT terms these will constitute a *reification* of MatRIC as broker and agent of change.

### 3.1. MatRIC's Objectives as broker and agent.

Sustained and meaningful transformation of students' learning experiences requires working with students directly, working with teachers, HEI leaders and policy makers, and engaging in research that informs, enriches and explores the learning-teaching dyad. Working towards MatRIC's stated vision therefore entails **three primary objectives** (see Figure 3): (1) Improvement of students' learning experiences; (2) Improvement of teaching; (3) Development and application of research into learning and teaching mathematics at university. Because of the complexity of HE mathematics education it is useful to identify **three secondary objectives** that relate to *participation* and *partnership*: (a) didactical development of student teaching assistants (STAs); (b) development of students as partners in learning, teaching and assessment; (c) development of active learning approaches and developing innovative approaches for teaching and assessment. Teaching and learning do not take place in a vacuum; the nested context of courses, programmes, institutions and national frameworks for mathematics education introduce affordances, constraints and goals for teaching mathematics. Substantial and sustainable transformation of teaching and learning entails changes within the context of teaching and learning. At this level, MatRIC can influence policy and practice; thus, in Phase 2, MatRIC will have **two tertiary objectives** (i) to influence course content and structure and (ii) to influence programme design and implementation. Figure 4 illustrates how these eight objectives are interconnected.

These eight objectives exist in a dynamic, organic and mutually interacting complex to facilitate participation in learning, teaching and research, and to effect changes within the practice of teaching and learning mathematics in HE. Actions directed towards one objective may have some impact on students' learning; substantial and sustained impact entails cultural development as the outcome of changes in all objectives. Unfortunately, the sequential (and simplistic) presentation of objectives and actions below does not fully capture the complexity of educational development undertaken by MatRIC.

## 4. Actions directed at MatRIC's objectives

Within this section attention is focused particularly on MatRIC's contribution to mathematics education. MatRIC has a more general impact locally within UiA, nationally and internationally. Especially within UiA MatRIC is one of several instruments of change applied to achieve UiA's strategy. MatRIC's more general contributions are considered in Section 5, 'Arenas of influence'.

### 4.1. Primary Objective 1: Transforming students learning experiences.

**The intention** is that students enjoy mathematics and are motivated to engage with the challenges of mathematics. They should feel themselves supported throughout their studies without lowering the cognitive demand to the extent that it interferes with their learning. The intention is that all students feel fully engaged as active learners and partners in learning, teaching and assessment.

Many students struggle with mathematics. In those programmes in which mathematics is learned as a 'service subject', for many students, performance in mathematics lies at the root of disappointing grades, failure, poor progression, and drop-out. There are many reasons underlying students' unhappy experiences with learning mathematics at university; these reasons do not occur singularly in discrete circumstances but as a complex dynamic that impacts on students' psychological, emotional, and social lives.

Students arrive at university unprepared for studying at this level. Many lack the required prior knowledge, many have not developed appropriate study skills, many have not developed the necessary competencies for independent mathematical thinking. The immediate impact can be to create an emotional burden that resists taking advantage of all the learning opportunities presented. In CPT terms, students need to be supported through an inward trajectory of participation to become full participants in their HE.

**MatRIC's actions directed at students' learning to address issues of participation**

**4.1.1 MatRIC TV**. *Goal*: to support students' transition from school to HE mathematics.
*Intended outcome*: Students better prepared to engage with HE mathematics content.

**4.1.2 Drop-in support**. *Goal*: to provide one-one tutorial support for students struggling with mathematics.
*Intended outcomes*: Students feel more secure when challenged by mathematics and are ready to engage with challenges because of the existence of learning support.

**4.1.3 Open lecture**. *Goal*: to present a 'popular' and accessible image of mathematics and studying mathematics.
*Intended outcome*: Students more motivated to engage with mathematics.

**4.1.4 Mathematics study skills course**. *Goals*: to motivate students' engagement in mathematics and to develop the study and thinking skills needed when studying university mathematics.
*Intended outcome*: Students as more effective and efficient learners of mathematics.

*Practically*, Target for these actions are UiA students, especially 1st year. The challenge is in making the actions known and getting students to engage. The above actions are advertised on screens in places where students gather, flyers, and announcements in classes will be used. Boxes for depositing compulsory assignments located in the Drop-in draw students to the location, 'coffee & cake' open days, and further efforts to engage with the student body and attract them to make use of the resources provided are used. MatRIC student interns (see 4.1.6 & 4.5.1) are contributing with developing on-line mathematics skills inventories, teaching and learning resources, and evaluation surveys. Actions are financed by UiA funding.

**MatRIC's actions directed at involving students to improve educational provision**

**4.1.5 Student Teaching Assistant (STA) development**. *Goal*: to improve the didactical and pedagogical competencies of mathematics STAs.
*Intended outcomes*: Students experience higher levels of satisfaction, enjoyment and personal achievement in their mathematics studies.

**4.1.6. Student internships**. *Goal*: To develop resources that will stimulate change in teaching and learning.
*Intended outcomes*: Resources that are of value in R&D based, innovative, active learning approaches.

*Practically*, STAs recruited from high performing advanced undergraduate and masters students through e-mail distributed by Examinations Office (confidentiality restricts sharing information and MatRIC making direct contact). Actions (see 4.5) carried out by UiA staff – MTs, MERs, PULS staff. Financed by UiA funding.

**The evaluation** of this objective will be through students' self-reports aligned with 'Studiebarometeret' administered by NOKUT. MatRIC, supported, by interns, is devising on-line instruments that can be incorporated into routine student evaluations of their courses to reach into the micro level that provides insights into students' experiences in individual courses. The assumption is that students supported and engaged as outlined above will enjoy higher performance, improved progression and be at less risk of failure and drop-out. MatRIC can seek funds from NFR to undertake the large-scale study that could test this assumption, but evaluation at this level is beyond the resources available to MatRIC.

Further actions to improve students' teaching and learning focus more directly on the secondary objectives; the intentions are to promote students as partners in learning, active learning approaches, innovation in teaching, and R&D based education. These are set out below (sections 4.4-6).

### 4.2 Primary Objective 2: Transforming mathematics teaching.

The overall intention of this objective is to build up the community of practice in mathematics education that MatRIC is energising in Phase 1. MatRIC's will continue to facilitate further exchange of experience, expertise and good practice between mathematics teachers within Norwegian HEIs, and connect these with international exemplars of best practice in teaching and learning mathematics. Specific objectives in the development of practice are the inclusion of research and development within regular teaching, and the comprehensive inclusion of students as partners in the educational process. MatRIC's actions contribute to UiA's strategy to give credit for teaching quality. MatRIC will support with competence, experience and resources the teachers seeking recognition for teaching quality.

**4.2.1**. **Innovation networks** (national & international). *Goal*: To develop a Norwegian expert group and facilitate exchange of ideas, resources and experiences of good, innovative, R&D based practice.
*Intended outcome*: A sustainable critical mass of networked HE MTs that stands as a pool of expertise in innovative mathematics teaching.

**4.2.2**. **Programme networks**. *Goal*: To develop Norwegian expert groups and facilitate exchange of programme specific innovation and good practice in mathematics teaching.
*Intended outcome*: A sustainable critical mass of networked HE MTs that is competent to contribute authoritatively to the development of courses, programmes and curriculums.

**4.2.3**. **Mathematics teaching Induction course**. *Goals*: To improve the quality of teaching of recently appointed HE mathematics teachers, to stimulate interest and inquiry in teaching HE mathematics, to raise the status of teaching HE mathematics, to contribute to community building as new participants join the enterprise of HE mathematics teaching.
*Intended outcomes*: MTs with basic didactical competencies that will support continued professional development, a prototype for subject specific didactical provision for HE teachers that will contribute to the Norwegian effort to give accreditation for good teaching in HE.

**4.2.4**. **Mathematics lunches**. *Goal*: to facilitate a discourse about teaching and learning mathematics.
*Intended outcome*: MTs meeting regularly to discuss issues about teaching and learning mathematics.

*Practically*, Actions 4.2.1-4.2.3 target all Norwegian HE mathematics teachers. Networks are facilitated and nourished by workshops, seminars conferences etc. The challenge to broaden participation is shared by MatRIC's dissemination media, Ambassadors and local coordinators (see below Section 4.7). Another challenge is to establish programme networks, this will be achieved through targeted events with international leaders and recruitment to serve on programme specific expert panels (see 4.3.5). Actions will be financed jointly from UiA and SFU funding; 4.2.4 from UiA funding.

**The evaluation** of this objective will be through basic metrics of participation and reach into institutions, faculties and departments. Also sought will be case studies from teachers such as were used to illustrate the self-evaluation document. Within UiA, it is possible to connect students' course evaluations with teaching innovation. Although desirable, systematic observation of teaching by researchers, operationalisation of practices and the correlation of practice with students' learning would be extremely expensive to implement and well beyond the resources of MatRIC.

### 4.3 Primary Objective 3: Research

**4.3.1. Research seminars and workshops**. *Goals*. To support the MatRIC research group at UiA including one post-doctoral and 6 PhD fellows, to support, encourage and develop a Norwegian community of researchers of university mathematics education.
*Intended outcomes*: (a) Literature reviews that inform other MatRIC objectives and actions; (b) high quality research, reported in international journals, conferences and research monographs contributing to knowledge about teaching and learning mathematics at HE; (c) evidence for 'MatRIC white papers' (see 4.3.5); A nationally connected community of researchers that is well-connected to the international network of researchers of university mathematics education (INDRUM, RUME, sigma, KHDM).

**4.3.2. Small R&D grants.** *Goal*: To stimulate MTs to engage in R&D projects that focus on MatRIC's vision within their own teaching.
*Intended outcomes*: Reports with empirical evidence from innovative teaching, R&D based teaching, active learning, etc. Systematic reflective inquiry into practice becomes a norm for HE MTs.

**4.3.3. International engagement and networking**. *Goals*: To lift Norwegian research in university ME to international levels of excellence, to contribute to the creation of knowledge internationally.
*Intended outcomes*: Scientific papers and reports in international journals and conferences. International exchange of researchers.

**4.3.4. Systematic inquiry into MatRIC's actions**. *Goals*: To ensure innovation promoted by MatRIC is research based, informed by scientific evidence and systematically evaluated.
*Intended outcomes*: Evidence based reports exposing students' learning experiences and outcomes from innovative teaching and learning as well as MTs regular practices.

**4.3.5. White papers**. *Goals*: to inform and influence policy and practice especially relating to the provision of mathematics as a service subject in Norwegian HEIs.
*Intended outcomes*: Evidence based reports from recognised expert groups of national repute.

*Practically*, 4.3.1 is led by MatRIC's research coordinator, who also acts as scientific adviser for 4.3.2-4.3.4. A small working group will be established to plan the implementation of 4.3.5. The target group for support is the whole community of Norwegian HE mathematics teachers, MERs focusing on university mathematics teaching, and students. Actions will be financed jointly by UiA and SFU funding.

**The evaluation** of this objective will be based on the production, quality and quantity of published reports. MatRIC's dissemination of research, opinion, and argument based on authoritative, informed and respected expert groups of practitioners (Ms, MTs, MERs & students) that MatRIC establishes and facilitates will influence educational leaders to reflect critically on the issues that make transition to HE and students' effective learning problematic.

### 4.4. Secondary Objective (a) didactical development of student teaching assistants (STAs);

**4.4.1. Summer training camp.** *Goals*: To develop STA's competencies in mathematics didactics, to build the team of STAs that will strengthen their resolve to provide high quality teaching and learning support.
*Intended outcomes*: Students experiencing teaching and learning approaches of consistently high quality.

**4.4.2. Regular mentoring of STAs**. *Goals*: To strengthen STA's competencies through on-going support, to engage teachers effectively in those parts of course provision devolved to STAs.
*Intended outcomes*: Teachers recognition of the value of STA's contribution, teachers responsive to experiences of STA's meetings with students, students experiencing teaching and learning approaches of consistently high quality.

*Practically*, recruitment of STAs and implementation of actions is outlined briefly in sections 4.1.5 & 4.1.6. Actions will be financed from UiA funding.

**The evaluation** of this objective will be through STA's reports and the course evaluations that students regularly provide. This will feature in the enhanced evaluation described above (4.1.5, 4.1.6).

### 4.5. Secondary Objective (b) development of students as partners in learning, teaching and assessment;

**4.5.1. Internships**. *Goal*: To demonstrate the potential of students as contributors to their education.
*Intended outcomes*: Teachers are more aware of students as producers of knowledge and resources, students experience greater involvement in their studies.

**4.5.2. Student teaching assistants**. *Goal*: To strengthen educational partnership between teachers and STAs.
*Intended outcomes*: Teacher's increasing awareness of the value and effectiveness of student peer mentoring and increasing readiness to explore other areas in which students may share in teaching, learning and assessment more generally.

**4.5.3. Engaging with and learning from external networks**. *Goal*: to connect with and learn from international experience.
*Intended outcome*: MTs participating in international groups such as RAISE and ISISP.

*Practically*, 4.5.1 - following successful experience at UiA, and the example of the **sigma** network in the UK MatRIC can initiate a national competition to fund a small number of internships in other Norwegian HEIs, these internships would need to be focused on MatRIC's vision. 4.5.2 (see 4.1.6). 4.5.3 leading and encouraging participation in the international events and inviting leaders from RAISE and ISISP to present at MatRIC events will be used to mobilise action. Actions will be financed jointly from UiA and SFU funding.

**The evaluation** of this objective will be based on separate evaluations of the three disparate actions above. Internships will be evaluated by exploring interns' experiences, and teachers' reactions. STAs will be evaluated as for secondary objective (a). Engagement in external networks will be evaluated by basic metrics of participation, and also on evidence of changes in practice and discourse about teaching, learning and assessment. A good outcome from this action would be several pilot studies in which teachers undertake carefully controlled experiments with students as partners in learning, teaching and assessment.

### 4.6. Secondary Objective (c) development of active learning approaches, developing innovative approaches for teaching and assessment.

**4.6.1. MatRIC R&D grants**. *Goal*: To encourage MTs to engage in innovative teaching approaches.
*Intended outcome*: Partnerships between MTs, MERs and students working on teaching and learning development

**4.6.2. Participation in MatRIC innovation networks**. *Goal*: To support MTs and student groups on an inward trajectory of participation in MatRIC's CoP focused on transforming and improving students' learning experiences.
*Intended outcome*: Sharing and replication of innovative teaching between MTs and across HEIs.

*Practically*, opportunities to participate in these actions are announced through MatRIC's channels of communication, by MatRIC Ambassadors, and local coordinators (see 4.7). MatRIC's Research Coordinator has scientific oversight of the R&D grants, network coordinators will oversee events and actions. Actions financed from SFU funding.

**The evaluation** will be based on the number of pilot projects developing active learning approaches and the reports arising from these, demand for MatRIC support and participation in MatRIC networks.

### 4.7. Tertiary Objective (i) to influence course structure and content

MatRIC has an important role in promoting greater variety in teaching and learning, and through MatRIC networks, pointing to experience and competence that can be shared.

**4.7.1. White papers** (see 4.3.5 above)

**4.7.2. Ambassadors**. *Goal*: To extend MatRIC's reach and communicate MatRIC's vision, agenda and opportunities for engagement and f or MatRIC to learn about innovative practices in other HEIs
*Intended outcomes*: Presentation of MatRIC within every Norwegian HEI mathematics provider within a 2,5-year period. Increased participation in MatRIC's activity.

**4.7.3. Local coordinators**. *Goal*: To have a known and relatively stable contact person within each local HE community of MTs.
*Intended outcome*: Improved communication of MatRIC's activity and increased participation in MatRIC's actions. Improved dissemination of MatRIC's products (reports, and learning resources).

*Practically*, 4.7.1 will be dependent on setting up expert groups. Ambassadors' visits will be initiated either by requests from the Ambassador or MatRIC leader, or invitation from an HEI – the possibility of such visits will be advertised. Local coordinators will be recruited through existing contacts, events and ambassador visits. Financed from SFU funding.

**The evaluation** of this objective will be based on evidence of the use and influence of the white papers in discussions about course structure and content. Invitations to MatRIC to contribute to national discussions about policy and curriculum. Also, Ambassadors' success to reach HE Ms and MTs throughout Norway, the attraction of an ever widening and varied participation in MatRIC's actions, the existence of a comprehensive network of local coordinators.

### 4.8. Tertiary Objective (ii) to influence programme design and implementation.

Research evidence points to the beneficial effects of smaller classes, with mathematics effectively integrated within programmes of study, taught by mathematics specialists, with applications of mathematics to the user programme. This requires partnership between mathematics teachers and academics from the 'host' discipline. Smaller classes improve teacher accessibility, enable better, faster assessment and feedback, active learning approaches, and better opportunities to tailor courses to individual student's needs. However, it is also recognised that there are very strong economic arguments in addition to deeply embedded cultural mathematical practices seeking to preserve the status quo. MatRIC's view will be promoted by sharing examples of better practice in

which the improved quality of student performance outweighs the economic argument and reinforces the educational argument.

**4.8.1. White papers** (see above)

**4.8.2. Ambassadors** (see above)

**4.8.3. Local coordinators** (see above)

*Practically,* MatRIC needs to grab attention of policy makers and leaders. Communication skills will be emphasised when seeking a co-Director (see Section 6). UiA's communication department will assist.

**The evaluation** of this objective will be similar to 4.7 above.

**NB** - Not included in the complex of objectives focused on learning, teaching and researching set out above, but nevertheless a crucial objective within MatRIC's operation:

**Dissemination** – see Self-Evaluation and Annual Report to NOKUT for 2016 (reproduced in the appendix).

## 5. Relations and arenas of influence

### 5.1. Local: UiA

MatRIC's actions, intended to transform mathematics education at UiA and nationally, are entirely consistent with UiA's strategy. The areas of MatRIC's objectives and the intersection with the focuses of UiA's strategy are illustrated in figure 2. UiA will strengthen MatRIC's role within the university by using MatRIC's actions as models and prototypes for the broader developments sought within UiA. For example, the support structures and developmental approaches for students (Drop-in, resource development such as MatRIC TV, STA development) are a proving ground providing experience for the proposed teaching and learning development centre. UiA will use MatRIC's actions intended to develop active learning approaches, students as partners in teaching and learning, and R&D based education as models of good practice to drive institutional developments. MatRIC's actions focused towards the transformation of teaching, such as the use of small R&D grants, MatRIC's induction teaching course and focus on innovation in teaching and learning provide mathematics teachers with evidence for seeking accreditation of high quality teaching. UiA will ensure that all teachers are cognizant of the advantages experienced by MTs and offer similar opportunities to teachers in other disciplines. The development of mathematical modelling projects based on the US, PIC Math project will be used by UiA to demonstrate how student experiences within local industries and enterprises can be used to advantage within students' studies as pursued in UiA's strategic focus 'Social involvement and innovation'. MatRIC's international network is presented within the institution as a practical example of UiA's strategic focus 'global mind set'.

### 5.2. National

The students' transformed learning experiences will arise through transformed participation in the practice of HE mathematics, and transformation of the practice. MatRIC's actions set out to achieve both transformations; students' participation at UiA, and teaching and learning practices within MatRIC's networks provide examples within MatRIC events and publications. MatRIC's intention to be a national agent for the transformation of HE mathematics education can be achieved in concert with other national bodies such as UHR, NMR and collaborating partners NSMO and NTNU. Actions set out above entail participation at a national level and seek to influence policy and practice at a national level (e.g. innovation and programme networks, teaching induction course, research and 'white papers'). Practically this will involve MatRIC Ambassadors, local coordinators, network coordinators and expert groups to promote MatRIC's actions and products, because the actions and products are of high quality and of value as instruments of change sought within an institution. Experience of mathematics teaching development indicates that 'projects' such as MatRIC are more likely to have an effect as an instrument of change fitting another institution's established agenda, rather than as a change agent per se.

### 5.3. International

MatRIC has developed an international network mainly with the intention of introducing expertise, experience, knowledge and competence to Norwegian HE MTs. MatRIC has also supported an outward flow of knowledge and expertise through international conferences, collaborative projects with institutions in the Czech Republic, and other presentations on 'foreign soil'. MatRIC and the Norwegian HE ME community continue to have much to gain from the inward flow of knowledge, especially as noted in Section 4.5 the development of students as partners in

learning. In Phase 2 the intention is to contribute to a greater outward flow of knowledge through international collaborations (e.g. H2020 Erasmus+ and Innovative training networks).

**6. Leadership**

Changes to MatRIC's Management Board are proposed, to take effect as soon as agreement is given by the Board. The intention is to include a wider representation from UiA as host institution. Changes proposed are to extend student representation to include a member from UiA's Student Association, the Director of UiA's Educational Development and Learning Centre, and the Dean of Teacher Education. Proposals to expand the International Advisory Board to include leaders of two major Norwegian stakeholder organisations will be implemented when the second phase of funding is announced.

Present network coordinators will collaborate and take on a more active operational role, with less dependence on MatRIC's Director. A Co-Director will be appointed to share responsibilities with the present Director and to provide greater management resilience. The appointee will bring complementary competencies with a key responsibility being the development and implementation of a new communications strategy. MatRIC coordinators aligned to educational programmes (economics, engineering, natural sciences, health science, etc) will be sought, from other HEIs as well as UiA.

**7. Sustainability**

To ensure sustained growth MatRIC will: be relevant to HE MT's practice; organise events and actions that interest HE MTs and attract participation; be experienced as an active partner in the quest for excellent mathematics education. To achieve this, MatRIC will listen to the ME community, learn and adapt as necessary. MatRIC's vision for Phase 2 will be sustained through the development of momentum of a critical mass of HE mathematics teachers who are networked and collaborating in innovation that leads to transformed teaching and learning. Changes that MatRIC promotes and supports across Norway, particularly in terms of course and curriculum design, will demonstrate their effectiveness in improving the student learning experience and thus will become embedded in the fabric of mathematics learning in HE. MatRIC will seek to embed national events within the biennial MNT conference organised by UHR. Local actions in student support, teaching and learning development, and international networking will be sustained through the university's strategy. By the end of Phase 2, MatRIC will have established its place within UiA and become so crucial to the on-going implementation of its strategy Learning and Education for the Future that UiA will ensure that MatRIC activity continues.

o Action Plan for Phase 2, figures and tables.

MatRIC Centre for Research, Innovation and Coordination of Mathematics Teaching

**MatRIC Action Plan for Phase 2**

**Appendix**

**Action Plan Appendix Part 1. Figures**

**MatRIC's focus**

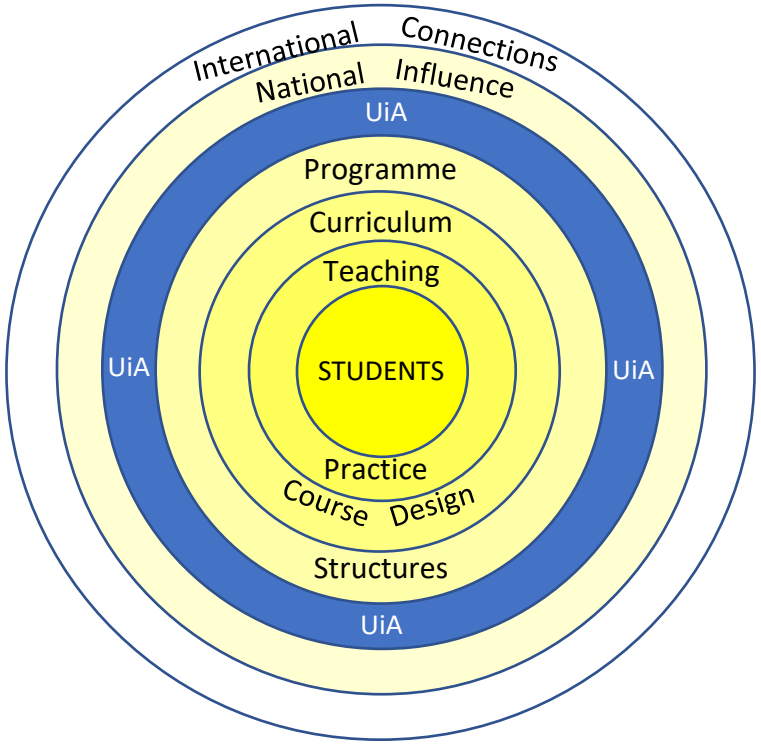


*Figure 1: MatRIC's focus and expanding field of vision*

**MatRIC's focus: Students at the centre,** their transformed experience is dependent on high quality teaching, which takes place within the context of course and programmes designed for educational excellence. MatRIC's primary actions to transform students' learning experience provides exemplars and prototypes for educational development within the University of Agder (UiA). MatRIC's primary actions to transform teaching is designed to include mathematics teachers from all Norwegian HE institutions and international leaders in teaching mathematics and university level mathematics education research. In Phase 2 MatRIC will use the networks of national and international teachers and researchers to influence policy and practice at national and international levels.

**The coherence between MatRIC's vision and UiA's strategy:**

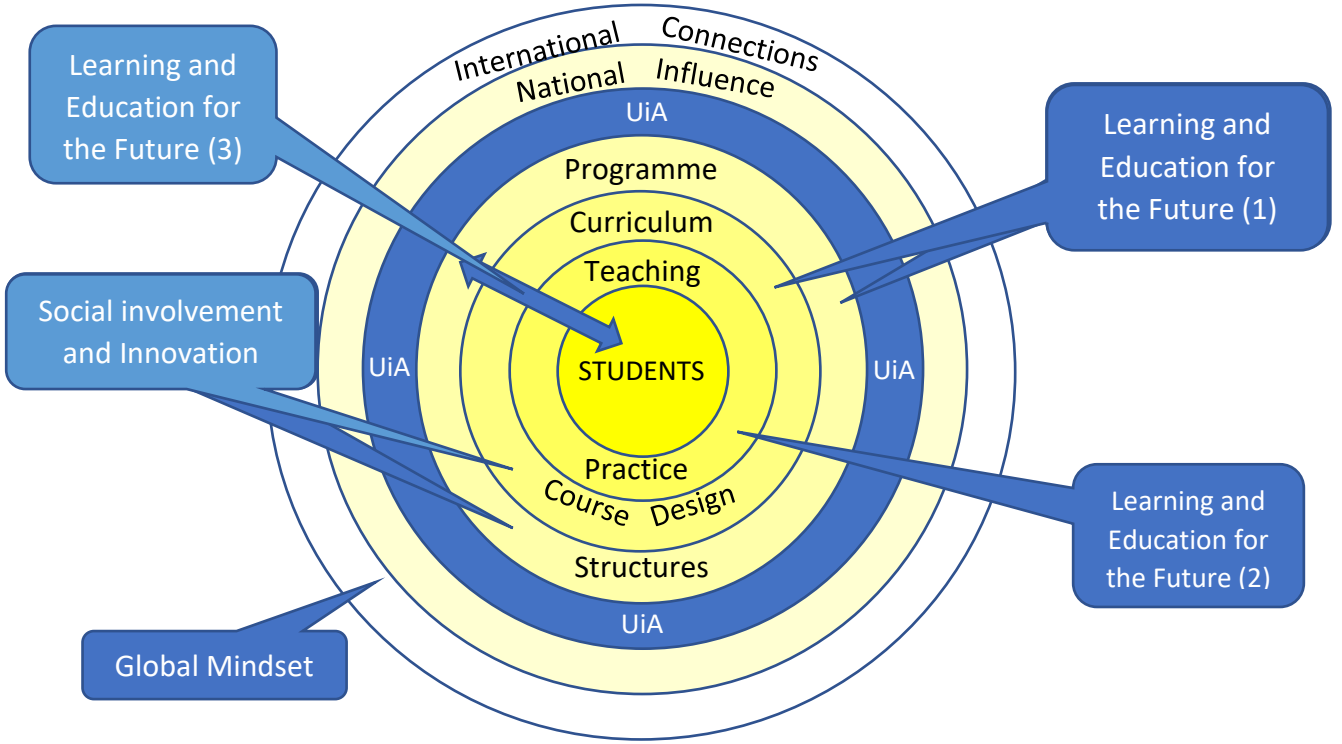


*Figure 2 MatRIC's contribution to UiA's strategy. The blue 'callouts' show the coherence of MatRIC's vision with UiA's strategy. UiA's vision is Co-creation of Knowledge and the strategy has three focus areas: Learning and Education for the Future; Social Involvement and Innovation; and Global Mindset.*

**Central pillars of MatRIC's objectives**

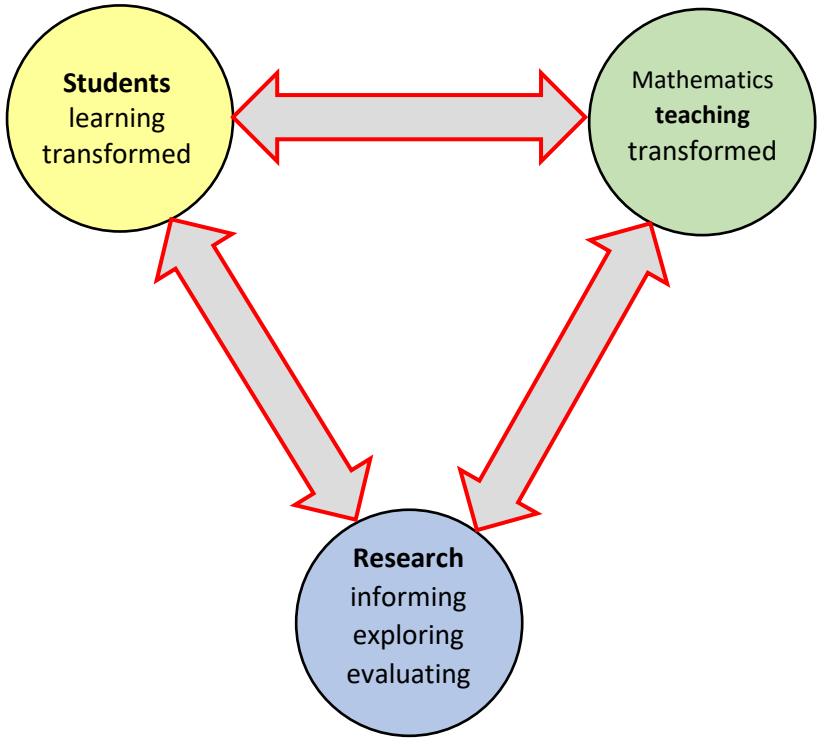


*Figure 3. MatRIC's primary objectives: (1) transformation of students' learning, (2) transformation of teachers' teaching, (3) applied research that informs, explores and evaluates mathematics teaching and learning in higher education. Reaching these objectives will advance Norwegian mathematics education towards MatRIC's vision, and* ***Norway will be a global leader in HE mathematics learning, teaching and research.***

**MatRIC's interconnected objectives**

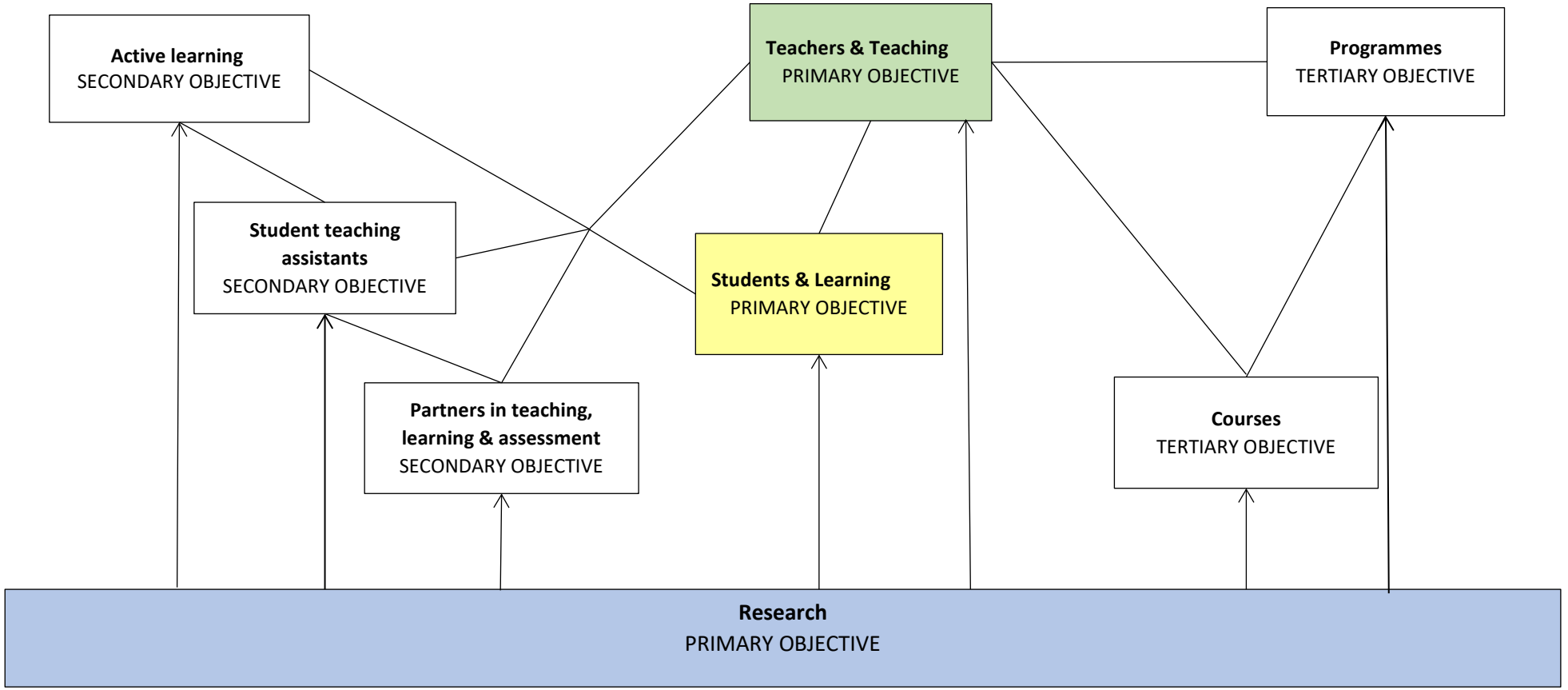


*Figure 4: MatRIC's Primary & Secondary objectives and (tertiary level) objectives for 'influence'.*

**Summary of MatRIC's actions proposed for Phase 2**

| Action | Goal | Intended outcome | Implementation | People involved | Responsible | Evaluation | Contribution to UiA |
|---|---|---|---|---|---|---|---|
| **Actions directed towards students** | | | | | | | |
| 4.1.1: MatRIC TV | To support students' transition from school to HE mathematics. | Students better prepared to engage with HE mathematics content. | Recordings of phase 1 nearly complete. Marketing is prioritized. | Students<br>Mathematics teachers<br>Student interns | TV production group drawn from several Norwegian universities. UiA studios. | Viewing metrics.<br>Student evaluation questionnaires | MatRIC creates models and prototypes that UiA will use in informing, motivating and leading the strategy 'Learning and education for the future'.<br><br>MatRIC's development of Drop-in learning support provides a model and experience for the development of the proposed UiA centre for learning and teaching.<br><br>Mathematics subject focused development of didactical competencies for Student teaching assistants can be copied into other subject areas in which STAs are used. |
| 4.1.2 Drop-in support. | To provide one-one tutorial support for students struggling with mathematics. | Students feel more secure when challenged by mathematics and are ready to engage with challenges because of the existence of learning support. | Target for these actions are UiA students, especially 1st year. The challenge is in making the actions known and getting students to engage. The above actions are advertised on screens in places where students gather, flyers, and announcements in classes will be used. Boxes for depositing compulsory assignments located in the Drop-in draw students to the location, 'coffee & cake' open days, and further efforts to engage with the student body and attract them to | Students, tutors (mathematics teachers, student teaching assistants) | Drop-in leaders.<br><br>MatRIC leadership, UiA communications department and student organization for marketing. | Student evaluation questionnaires.<br><br>Usage metrics | |
| 4.1.3 Open lecture. | To present a 'popular' and accessible image of mathematics and studying mathematics. | Students more motivated to engage with mathematics. | | Students | MatRIC leadership. | Attendance metric | |
| 4.1.4 Mathematics study skills course. | To motivate students' engagement in mathematics and to develop the study and thinking skills needed when studying university mathematics. | Students as more effective and efficient learners of mathematics. | | Students, mathematics teachers, mathematics education researchers | Study skills course leader. | Student evaluation questionnaire | |

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| | | | make use of the resources provided are used. | | | | MatRIC's development of on-line questionnaires for students' course evaluations is a model to be used across the university. |
| 4.1.5 Student Teaching Assistant (STA) development.<br>4.4.1. Summer training camp.<br>4.4.2. Regular mentoring of STAs. | to improve the didactical and pedagogical competencies of mathematics STAs.<br>to build the team of STAs that will strengthen their resolve to provide high quality teaching and learning support.<br>to engage teachers effectively in those parts of course provision devolved to STAs.<br>To strengthen educational partnership between teachers and STAs. | Students experiencing teaching and learning approaches of consistently high quality.<br>Students experience higher levels of satisfaction, enjoyment and personal achievement in their mathematics studies.<br>Teachers recognition of the value of STA's contribution, teachers responsive to experiences of STA's meetings with students, students experiencing teaching and learning approaches of consistently high quality.<br>Teacher's increasing awareness of the | STAs recruited from high performing advanced undergraduate and masters students through e-mail distributed by Examinations Office | Students<br>UiA staff – MTs, MERs, PULS staff. | Course leaders<br>Mathematics teachers | Student evaluation questionnaire | |

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| | | value and effectiveness of student peer mentoring and increasing readiness to explore other areas in which students may share in teaching, learning and assessment more generally. | | | | | |
| 4.1.6. Student internships.<br>4.5.1<br>4.5.2 | To develop resources that will stimulate change in teaching and learning.<br>To demonstrate the potential of students as contributors to their education. | Resources that are of value in R&D based, innovative, active learning approaches.<br>Teachers are more aware of students as producers of knowledge and resources, students experience greater involvement in their studies. | undergraduate and masters students through e-mail distributed by Examinations Office following successful experience at UiA, and the example of the sigma network in the UK MatRIC can initiate a national competition to fund a small number of internships in other Norwegian HEIs, these internships would need to be focused on MatRIC's vision. | | | | |
| **Actions focused towards mathematics teachers** | | | | | | | |
| 4.2.1. Innovation networks | To develop a Norwegian expert | A sustainable critical mass of | Target all Norwegian HE | Mathematics Teachers | MatRIC leadership | Event evaluations, | MatRIC's promotion of |

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| 4.6.2 | group and facilitate exchange of ideas, resources and experiences of good, innovative, R&D based practice.<br>To support MTs and student groups on an inward trajectory of participation in MatRIC's CoP focused on transforming and improving students' learning experiences. | networked HE MTs that stands as a pool of expertise in innovative mathematics teaching.<br>Sharing and replication of innovative teaching between MTs and across HEIs. | mathematics teachers.<br>opportunities to participate in these actions are announced through MatRIC's channels of communication, by MatRIC Ambassadors, and local coordinators<br>Networks are facilitated and nourished by workshops, seminars conferences etc.<br>The challenge to broaden participation is shared by MatRIC's dissemination media, Ambassadors and local coordinators (see below Section 4.7). Another challenge is to establish programme networks, this will be achieved through targeted events with international leaders and recruitment to | International guests<br><br>Students | Network coordinators<br><br>Conference programme committee | Participation metrics | innovative, R&D based education, and student participation creates examples and models that promote actions elsewhere. |
| 4.2.2. Programme networks. | To develop Norwegian expert groups and facilitate exchange of programme specific innovation and good practice in mathematics teaching. | A sustainable critical mass of networked HE MTs that is competent to contribute authoritatively to the development of courses, programmes and curriculums. | | | | | MatRIC's influence within UiA in course and programme development will be strengthened through the collaboration in these networks. |
| 4.2.3. Mathematics teaching Induction course. | To improve the quality of teaching of recently appointed HE mathematics teachers, to stimulate interest and inquiry in teaching HE mathematics, to | MTs with basic didactical competencies that will support continued professional development, a prototype for subject specific didactical provision | | | | | MatRIC is creating a prototype for university level didactical education. This will form an important element in UiA's teaching accreditation award scheme. For |

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| | raise the status of teaching HE mathematics, to contribute to community building as new participants join the enterprise of HE mathematics teaching. | for HE teachers that will contribute to the Norwegian effort to give accreditation for good teaching in HE. | serve on programme specific expert panels | | | | MTs. There will be a demand for similar support from other areas, otherwise MTs will be seen to be in an advantageous position. |
| 4.2.4. Mathematics lunches. | to facilitate a discourse about teaching and learning mathematics. | MTs meeting regularly to discuss issues about teaching and learning mathematics. | Discussion about teaching and learning. Development of MT community at UiA | | Mathematics teachers | Participation. MTs decide when they want to meet, metrics about meetings, informal reports of discussions | A simple model for teaching development within a CPT framework. |
| **Actions focused towards research** | | | | | | | |
| 4.3.1. Research seminars and workshops. | To support the MatRIC research group at UiA, to support, encourage and develop a Norwegian community of researchers of university mathematics education. | (a) Literature reviews that inform other MatRIC objectives and actions; (b) high quality research, reported in international journals, conferences and research monographs contributing to knowledge about teaching and learning mathematics at HE; (c) evidence for 'MatRIC white papers'; A | Organised by the research group (PhD and post-doctoral fellows) in collaboration with MatRIC's research coordinator. | Community of Norwegian HE mathematics teachers, MERs focusing on university mathematics teaching, and students. | Led by MatRIC's research coordinator | Production, quality and quantity of published reports. MatRIC's dissemination of research, opinion, and argument based on authoritative, informed and respected expert groups of practitioners (Ms, MTs, MERs & students) | Exemplary of active research groups that UiA is promoting throughout the university. |

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| | | nationally connected community of researchers that is well-connected to the international network of researchers of university mathematics education (INDRUM, RUME, sigma, KHDM). | | | | | |
| 4.3.2. Small R&D grants.<br>4.6.1 | To stimulate MTs to engage in R&D projects that focus on MatRIC's vision within their own teaching.<br>To encourage MTs to engage in innovative teaching approaches. | Partnerships between MTs, MERs and students working on teaching and learning development<br>Reports with empirical evidence from innovative teaching, R&D based teaching, active learning, etc.<br>Systematic reflective inquiry into practice becomes a norm for HE MTs. | Announced through MatRIC's channels of communication, reinforced by Ambassadors and local coordinators. | | Scientific advisor: MatRIC research coordinator | | Promoted within UiA to support teaching development, collaboration across fields of scholarship (MTs, MERs). A model to be copied elsewhere. |
| 4.3.3. International engagement and networking. | To lift Norwegian research in university ME to international levels of excellence, to contribute to the creation of | Scientific papers and reports in international journals and conferences.<br>International | Support to attend conferences where there is a focus on researching university level mathematics education or | | | | A model for UiA's strategic focus 'Global mindset'. |

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| | knowledge internationally. | exchange of researchers. | innovative teaching approaches | | | | |
| 4.3.4. Systematic inquiry into MatRIC's actions. | To ensure innovation promoted by MatRIC is research based, informed by scientific evidence and systematically evaluated. | Evidence based reports exposing students' learning experiences and outcomes from innovative teaching and learning as well as MTs regular practices. | PhD research, masters and bachelor level studies identified and supported by MatRIC coordinators, leaders, research supervisors and those engaged in MatRIC's actions. | | | | MatRIC's approach to systematic inquiry into innovation and actions to explore teaching and learning is a model to be used to promote similar action across UiA. |
| 4.3.5. White papers.<br>4.7.1<br>4.8.1 | To inform and influence policy and practice especially relating to the provision of mathematics as a service subject in Norwegian HEIs. | Evidence based reports from recognised expert groups of national repute. | To be decided by a working group set up for this purpose. Implementation is likely to involve MatRIC's research groups, innovation and programme networks. | | Small working group set up by MatRIC leadership to plan implentation | | Will be used to support MatRIC's arguments to influence practice at UiA. |
| 4.5.3. Engaging with and learning from external networks. | To connect with and learn from international experience. | MTs participating in international groups such as RAISE and ISISP. | Leading and encouraging participation in the international events and inviting leaders from RAISE and ISISP to present at MatRIC events will be used to mobilise action. | MTs and students | Initially MatRIC leadership. | Engagement in external networks will be evaluated by basic metrics of participation, and also on evidence of changes in practice and discourse about teaching, learning and assessment. A good outcome from this action would be several pilot studies in which teachers | MatRIC provides a model of student-teacher partnership to be used to influence other areas of the university. |

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| | | | | | | undertake carefully controlled experiments with students as partners in learning, teaching and assessment. | |
| **Actions focused towards maintaining contact with the Norwegian HE mathematics education community** | | | | | | | |
| 4.7.2. Ambassadors. | To extend MatRIC's reach and communicate MatRIC's vision, agenda and opportunities for engagement and For MatRIC to learn about innovative practices in other HEIs | Presentation of MatRIC within every Norwegian HEI mathematics provider within a 2,5-year period. Increased participation in MatRIC's activity. | Ambassadors' visits will be initiated either by requests from the Ambassador or MatRIC leader, or invitation from an HEI – the possibility of such visits will be advertised. | Ambassadors appointed by MatRIC | Management Board for appointing Ambassadors. MatRIC leadership and Ambassadors responsible for making contact with the user community. | Evidence of the use and influence of the white papers in discussions about course structure and content. Invitations to MatRIC to contribute to national discussions about policy and curriculum. Also, Ambassadors' success to reach HE Ms and MTs throughout Norway, the attraction of an ever widening and varied participation in MatRIC's actions, the existence of a comprehensive network of local coordinators. | |
| 4.7.3. Local coordinators. | To have a known and relatively stable contact person within each local HE community of MTs. | Improved communication of MatRIC's activity and increased participation in MatRIC's actions. Improved dissemination of MatRIC's products (reports, and learning resources). | Recruited through existing contacts, events and ambassador visits. | MTs in Norwegian universities. | MatRIC leadership, network coordinators, Ambassadors and other contacts to identify possible coordinators. | | |
| See also dissemination report below. | | | | | | | |

**Dissemination (Copied from 2016 Annual report)**

MatRIC has four intertwined strands of dissemination, each serving a different purpose: 1. Awareness, 2. Understanding, 3. Action, 4. Self-generating sustainable development.

**Dissemination for Awareness**

**MatRIC web site**

Content: announcements of MatRIC events, reports of MatRIC activities, repository of MatRIC resources, source of information about MatRIC.

Message: MatRIC is a busy 'Centre', a resource that seeks to serve the Norwegian community of mathematics teachers working in higher education.

Target group: All stakeholders – mathematics teachers, students, policy makers, institutional leaders.

**MatRIC Newsletter**

Content: Short text pointing to recently posted announcements or articles on MatRIC web pages.

Message: Brief statements about what is new in MatRIC.

Target group: All stakeholders, distributed to those who have signed up to receive the Newsletter and anyone who has attended a MatRIC event. It is possible to 'sign-up' at www.matric.no.

**Social media (Facebook)**

Content: Brief announcements of what is happening.

Message: MatRIC is busy 'NOW'!

Target group: Friends of MatRIC – who we hope will forward to a wider group of 'stakeholders'.

**INFOMAT (On-line Newsletter of the Norwegian mathematical Society)**

Content: Brief announcements of MatRIC's programme and events.

Message: Invitation to participate in MatRIC activities.

Target group: Mathematicians and mathematics teachers in Norwegian higher education institutions.

**alle@matematikknettverket.no (e-mail list used by mathematics teacher educators in Norway)**

Content: Brief announcements of MatRIC's programme and events that are relevant to mathematics teacher educators.

Message: Invitation to participate.

Target group: Mathematics teacher educators working in Norwegian institutions of higher education.

**SFU Magazine**

Content: Articles about SFU activity

Message: Excellent practice in teaching and learning in higher education – student engagement, student as partners in learning, research and development based education.

Target group: All stakeholders (Policy makers, leaders, teachers and students) in the Centre for Excellence programme and those who aspire to be awarded Centre for Excellence status. Also an international readership to display a Norwegian 'flagship' educational development programme.

**Personal contact**

Content: Information about MatRIC events.

Message: Invitation to participate.

Target group: Mathematics teachers and others working to develop the quality of mathematics teaching and learning in higher education.

**Dissemination for Understanding**

**Workshops, colloquiums, symposiums, seminars, conferences,**

Content: Reports of Innovation, reports of research into innovation and developmental efforts carried out in Norway and internationally.

Message: Inspirational and explanatory. To stimulate research, innovation, development and networking amongst higher education mathematics teachers.

Target group: Mathematics teachers (and students) in higher education.

**Journal articles**

Content: Scientific research papers.

Message: New knowledge about quality of effectiveness of alternative approaches to teaching and learning mathematics at university.

Target group: Mathematics education researchers and teachers.

**Mathematics Teachers' Lunches**

Content: Conversation

Message: Informal reports of what is happening in colleagues' classrooms, assessment approaches etc.

Target group: Local community of mathematics teachers working on the same campus.

**Dissemination for Action:**

Networks' activities (other than events),

Content: Innovation and research actions.

Message: Join in partnership of activity for joint enterprise, mutual engagement and the development of a shared repertoire (based on Community of Practice Theory).

Target group: Mathematics teachers in institutions of higher education, and students.

**Induction Teaching course**

Content: Approaches and didactical techniques related to teaching mathematics in higher education, to large groups and as a service subject. Innovations in teaching, learning and assessment using modern and emergent technologies.

Message: Effective teaching needs to be reflective, resourceful, creative and informed by best/excellence in practice.

Target group: Newly appointed teachers of mathematics in higher education institutions.

**Dissemination for self-generating sustainable development:**

**MatRIC small research grants,**

Content: Open, for proposers to define their own research and development actions within their own practice.

Message: Research is fundamental to innovation and development in teaching. It is necessary to understand what is happening in teaching and learning actions, the dissemination of knowledge through reporting is essential to take the field forward. Didactical research is within the grasp of all teachers and an essential part of regular practice.

Target group: Mathematics teachers in higher education.

**Support for innovation and collaboration.**

Content: Open, for teachers and students to define their own research and development actions within their own practice.

Message: Innovation in teaching, learning and assessment is at the heart of educational practice that seeks to achieve 'excellence'.

Target group: Colleagues and students within the University of Agder. The outcomes of the innovative practice to be reported at MatRIC and other events.

**Summary comment**

MatRIC sets out to involve mathematics teachers from other higher education institutions within Norway and to network these, with international experts in a community that is determined to work for excellence in teaching and learning mathematics. MatRIC aims to make participation accessible by covering accommodation costs and locating events around Norway. The most effective form of dissemination is personal contact. Further, communication needs to be a two-way process, MatRIC needs to listen and respond as well as announce and invite a response. MatRIC events and actions in the networks and opportunities such as the small research grants must be adjusted to align with the target groups. In 2017 MatRIC extended the dissemination effort by the appointment of 'envoys/ambassadors' who will visit other higher education institutions, both to take the message MatRIC wants to convey and bring back the information MatRIC needs to hear.