

MatRIC Centre for Research, Innovation and Coordination of Mathematics Teaching Annual Report for 2015 for The Norwegian Agency for Quality Assurance in Education.

1. Abstract

Throughout 2015 MatRIC has been faithful to the profile and vision set out in the proposal documents.

The proposed Centre for Research, Innovation and Coordination of Mathematics Teaching (MatRIC) will focus on mathematics teaching and learning within the study programmes of other subjects such as engineering, natural sciences, economics and teacher education. MatRIC will:

- *Create, lead and support networks that enable sharing and development of effective use of video, digital and web-based technologies in teaching, learning and assessing mathematics.*
- *Initiate, support and disseminate research into teaching, learning and assessing mathematics to identify, understand and evaluate effective innovation in practice.*
- *Bring together mathematics educators, scientists, engineers, computer scientists and economists in cross-disciplinary teams to produce workplace simulations and realistic tasks for mathematical modeling.*

Vision: The Centre will lead innovation, research and excellence in mathematics teaching and learning within higher education 'user programmes'.

This vision will be achieved through:

- Networking mathematics teachers and users (engineers, scientists, economists, teachers, etc.).*
- Coordinating research into innovation in teaching, learning and assessing mathematics.*
- Developing teaching resources that simulate applications of mathematics in the workplace and a student laboratory for developing competencies in mathematical modeling.*
- Disseminating research, innovation and excellence in mathematics teaching.*

(MatRIC proposal 2013)

MatRIC events serve several purposes. They develop a physical 'presence' of the Centre in Norway; they bring university level teachers together from throughout Norway and other countries and thus make an important contribution to networking and dissemination (these are central to MatRIC's workplan); they stimulate and illuminate innovation and research in teaching and learning mathematics at university level.

During 2015 there have been four events connected to MatRIC's workgroups (networks): (WP1-3¹; 3-1)

- Visualization and Simulation Symposium (Agder)
- Mathematical Modelling Colloquium (Agder)
- Computer Aided Assessment Colloquium (Bergen)
- Video Colloquium (Tromsø)

And MatRIC's annual conference (Trondheim). (WP1-2)

MatRIC has also been active locally, nationally and internationally within the University of Agder, nationally in collaboration with other higher education institutions and

¹ WP1-1, WP1-2, WP2-1, etc. refer to Work Packages and tasks in MatRIC's proposal.

- Collaboration with The Norwegian Association of Higher Education Institutions (UHR) in video production. (WP3-1)
- Development of MatRIC's web site (www.matric.no) to accommodate mathematics videos (and more). (WP1-1)
- University level mathematics teaching course (collaboration with NTNU). (new²)
- MatRIC small research grants (in 2015 with HiB, UiB, UiA). (WP2-3)
- Opening of mathematics support Drop in at UiA. (new)
- Seminars at UiA (Marc Habbema SOWISO – demonstration of e-learning platform; Prof. Tony Croft, Loughborough; Prof. Carl Winsløw, Copenhagen) (WP2 + Plans for 2015 in 2014 Annual Report)
- Mathematics teachers' lunches "How I teach mathematics" held on both UiA campuses intended to stimulate a discussion about teaching and develop the community of mathematics teachers within the university. (New).
- Collaboration with bioCEED – developing mathematical modeling in biology. (WP3-2)
- Centre visit to Mathematics Education Centre at Loughborough University (WP 1-4), focus on a Thematic Issue of NOMAD, a Nordic mathematics education journal. (WP4-2)
- Visits to 4 mathematics centres in Dublin, and one in Germany (Paderborn) (WP1-4)
- MatRIC Open Lecture with Håvard Tjora
- Development of international network – UK (Loughborough, Newcastle, Edinburgh); Germany (Paderborn, Hannover); Czech Republic (Brno); The Netherlands (Amsterdam); France (Montpellier); USA (San Diego, Arizona). (WP1-4)
- Participation in several international conferences (IMA, CERME, KHDM) (WP4-2)
- MatRIC Post-doctoral researcher has submitted for publication in a major international journal a literature review covering research into the use of video for teaching and learning mathematics in higher education. (WP2-1)
- Three MatRIC Newsletters were distributed (February, July, September), these are sent to nearly 300 recipients. (WP4-1)
- Three research proposals, INTPART (SIU/NFR) – not funded, FINNUT (NFR) – not funded; EAA/Norway Grants (funded) – Mathematics Education Through Modelling Authentic Situations (METMAS) a collaboration between MatRIC and Brno University of Technology.

2. Results compared to the application and plans

a. Which activities/projects have been conducted and what are the effects and results of these?

i) Which activities/projects have had the desired results?

The proposal set out expectations for two 'workshops' (colloquiums, symposium) connected to the workgroups/networks each year together with the annual conference. In 2015 four and a conference were arranged, this increase was a consequence of (1) transfer of funds from 2014, and (2) there was only one workshop in 2014. The events have attracted satisfactory participation, due to budget constraints the upper limit for workshops is 40, and for the conference 100. Actual participation was between 30 and 40 for the smaller events and nearly 70 for the conference. Each event is followed up with an evaluation questionnaire, typically the responses are favourable. Most participants report that they found the events useful and that their teaching would be influenced as a result of participation. Commitment to future participation in matric events is very high (approaching 100%)

² 'New' indicates that this action was not anticipated in the MatRIC proposal.

and readiness to recommend to colleagues to participate in MatRIC events is also high, (around 80%). (Reports from the surveys are available on request).

MatRIC events are announced and publicised using various means of communication: MatRIC Newsletter (sent to nearly 300 recipients), MatRIC's web pages, MatRIC's Facebook and twitter pages, INFOMAT (the e-newsletter of the Norwegian Mathematical Society), also word of mouth (e.g. an announcement at the annual meeting of the Norwegian Mathematics Council). It seems however that personal contact and invitation remain the most powerful means of attracting participation.

These events account for a significant part of MatRIC's budget because MatRIC covers the cost of the event, meals and overnight accommodation as required. In an attempt to assess the sustainability of the conference, participants were asked to indicate how likely they were to attend if MatRIC did not cover accommodation costs, only 24% indicated their participation would be *unlikely*. After only two years the annual conference has not yet become established in the regular calendar for mathematics teachers in higher education, nevertheless we believe the response to this question is a positive indicator – that MatRIC is meeting a need and MatRIC's effort is well- received.

It was decided during the year to change the name of MatRIC's 'workgroups' to 'networks'. We want to bring mathematics teachers together without there being an implied obligation to 'work', the name change is intended to lower the threshold for participation. The networks have developed in different directions, each successful in its own way – a production group for video, an interest group for visualization and simulation, a consultancy group for computer aided assessment, a research group for mathematical modelling – as briefly reported below.

A video network has emerged through the collaboration with UHR in which a resource to support students mathematics as they enter higher education to study science and technology programmes. A production group, led at MatRIC's invitation, by Prof. Tom Lindstrøm (UiO) includes mathematics teachers from HiOA, HSN (Høgskolen i Sørøst-Norge), HiST (now NTNU) and two others from UiO. Morten Brekke (UiA) is coordinator of the network, he is working on translating video resources bought under licence from Loughborough University. MatRIC's web-site has been developed to provide a home for the videos. The initial publication of MatRIC TV was greeted with much applause. We continue to support the video production, which takes place at the UiA studio in Grimstad. MatRIC has also entered an agreement with bioCEED for the production of statistics videos for biology students. One 'MatRIC' PhD fellow is researching video use in the context of flipped classrooms.

There is now a small network working on, using, or interested in mathematical visualisations and simulations to support teaching and learning. The network coordinator is Per Henrik Hogstad (UiA), other participants are Prof. A. J. M. De Jong (The Netherlands), Erlend Thune (ICT Centre, Tromsø), Knut Mørken (UiO), and connections to Norwegian centre for Science Education, publisher Cappelen Damm and users in universities and university colleges. An extensive collection of visualizations and simulations has been built up. One 'MatRIC' PhD fellow is researching this area, several masters projects and a developmental inquiry aimed at adapting the resource to meet the needs of teacher education students is on-going.

The Computer Aided Assessment colloquium held in June brought together, at MatRICs invitation, several national and international leaders in the field. This group later used the MatRIC conference as another opportunity to meet, and now the group plans to meet in Newcastle (UK) in the spring. As a first goal the group plans to produce a document setting out the minimum criteria that need to be met by any software that is introduced to higher education to support the assessment of mathematics. The development of this international network that will be of benefit to the Norwegian community shows the impact of MatRIC.

The proposal from MatRIC included the creation of a new journal to cover research in university level mathematics education. It has been decided not to pursue this because a new Springer journal addressing the field of undergraduate mathematics education has been introduced, and there are other well established journals that would include such papers. Instead we have agreed with the

editors of NOMAD a thematic issue on undergraduate mathematics education. This will be published in 2017.

New to the MatRIC programme in 2015 has been the development of a pilot 'Drop in' support/help centre for mathematics at UiA, this is based on the 'SIGMA' model in the UK. This addition to the MatRIC portfolio was taken as a result of the additional funding for centres of excellence in higher education announced in the national budget for 2015. This centre has attracted a lot of positive attention throughout the university and has also had an impact with one of our international collaborators who have been inspired by MatRIC's initiative to seek and receive an EEA Norway Grant to establish a Drop in at Masaryk University, Brno.

Another new initiative has been to pilot a mathematics teaching course for recently appointed mathematics teachers in universities and university colleges. MatRIC is providing the resources; the course is being organized with NTNU and held at the main NTNU campus in Trondheim. Eleven participants signed up for the course (we hoped for 15), the course director comes from UiA and course tutors come from UiA, NTNU and UiO. Presenters in the course have been invited from several Norwegian and international universities (UiA, NTNU, Molde UC, BI Stavanger, Roskilde U., San Diego State U., UiO, Manchester U. & Coventry U., UK,). The course is to run in three sessions – November 2015, March and June 2016. An evaluation will be included in the next annual report. Initial feedback from the first session was generally positive.

The abstract above indicates that during 2015 MatRIC activities have addressed all parts of the proposal – with the exception of one task in WP2-2 *"survey current efforts to improve the teaching, learning and assessment especially in the use of video, digital and web-based technology to establish a data base of practical information, insights and contacts for others interested in introducing similar innovations."* The issue is not neglected but being dealt with rather informally through active networking.

ii) *Which activities/projects have not had the desired results and what are the lessons to be learnt from this?*

We have been trying to encourage more student involvement in MatRIC's activities. One approach was to work with the tutor of a media studies course who agreed to set students as their compulsory (un-graded) assignment the production of a short video that would motivate pupils at upper secondary school to study mathematics within STEM programmes at university. Alongside the course evaluation of the videos, MatRIC offered a 'prize' in the form of purchasing high quality videos for publication on the MatRIC web site. Unfortunately the videos were not up to the standard that the course tutor was even prepared to share them with MatRIC for our evaluation. We learn that such videos need to be produced as a joint enterprise between mathematics and media classes because both sets of competencies and experiences are required.

A proposal for a research project within the research Council's FINNUT programme was submitted. This proposed research into students' use of and learning from mathematics video. At the time of reporting we know the proposal did not receive funding, but we have not received any evaluation from the Research Council of Norway.

iii) *Which activities/projects have not been carried out? Why have they not been carried out and what are the consequences?*

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MatRIC has had some involvement with teacher education programmes, through the small research grants. Further some master students on the teacher education programme contribute to the mathematics support in the Drop in. We continue to work on involving teacher education students

more actively in MatRIC. In this respect MatRIC must position itself within an existing and well developed mathematics teacher education community. What additional value can MatRIC bring. Some ideas relating to the development of student teachers mathematical knowledge for teaching (fitness for purpose) are now under discussion and we hope these will be piloted within UiA during 2016.

Plans for 2015 included, “the development of a ‘graduate school’ for PhD fellows, their supervisors and post-doctoral researchers who are researching on teaching and learning mathematics in higher education.” This was not pursued as an additional MatRIC activity. Instead we collaborated in a broader proposal to The Research Council of Norway for a graduate school in mathematics education (this was unsuccessful). Also we led a proposal within a programme set up by SIU and NFR for international partnerships (INTPART), which would have included a significant element of graduate school activity. Our INTPART proposal was highly rated ... but did not receive funding. At the end of the year (with deadline January 12, 2016) MatRIC participated in a proposal for an EU ‘Innovative Training Network’, which again includes a very significant element of graduate school type activities. The engagement with the international community is believed to be very important. Although the INTPART proposal was not funded we are making a continued effort to nurture the links with the communities in the USA that will bring benefit to the PhD fellows who are researching university level mathematics education. The MatRIC conference in November highlighted the research of PhD fellows with their presentation of their projects in parallel sessions.

b. Dissemination

Level 1 – Making MatRIC known:

locally – directed at students and colleagues within the university, making announcements on video screens displayed in student/public areas, using the university intranet, using student facebook, through the university research magazine ‘TEFT’ and the student news journal for Agder ‘Unikum’, presentation of MatRIC and the Drop in to ‘faddere’ who would introduce new students to the campus, advertised as a ‘selling point’ for UiA the MatRIC Drop in is featured in the university prospectus of course descriptions for potential students; internal meetings such as ‘Forum for Teacher Education’. Personal contact.

Nationally – directed at mathematics teachers and researchers in university level mathematics education at universities and university colleges, using the newsletter of the Norwegian Mathematical Society ‘INFOMAT’, MatRIC Newsletters, and other e-mail lists, MatRIC web pages (www.matric.no), MatRIC facebook, and MatRIC events, MatRIC’s presence at national conferences (e.g. MNT conference in Bergen; NOKUT conference Bergen). Directed at policy makers and leaders NOKUT’s SFU Magazine, presentation at Ministry of Education; NOKUT – SFU conference, Asker.

Internationally – directed at researchers in university level mathematics education, MatRIC’s presence at international conferences - IMA-MEE conference Loughborough; 12th International Conference on Technology in Mathematics Teaching held in Portugal; Didactics of Mathematics in Higher Education as a Scientific Discipline Invitation Conference Hannover). DMUK, ICMI. Karsten Smith invited Morten Brekke, distance teaching, digital learning. MatRIC is the starting point.

At all levels it is clear that personal contact and personal invitations are the most powerful means of making MatRIC known and engaging others in MatRIC activities.

Level 2 – MatRIC activities:

Nationally – MatRIC events directed principally at mathematics teachers at universities and university colleges – four symposium/colloquiums, MatRIC conference. MatRIC web pages.

Internationally – Conferences (as above), publication in conference proceedings.

Level 3 – Dissemination of results:

Nationally – as above.

Internationally – as above plus publication in international journals (one paper submitted).

3. R&D-based education and integrated models

a. How does the centre work with student-active learning methods in connection with R&D-based education and/or education based on artistic developmental work? How does the centre develop and enhance this? What is the added value of R&D-based education when it comes to learning outcomes and relevance? How does the centre operate structurally to develop R&D-based education?

MatRIC's main approach to promote R&D based education is through the small research grants that MatRIC introduced in 2014. Five grants were made during 2014 and a further four grants in 2015. These grants, up to 50000 NOK each, are intended as seed money to stimulate, especially action research type activity. More funds were set aside in the budget than used. The five 2014 grants were reported in 2015. These included:

Kjellrun Hiis Hauge, Bergen University College, received a MatRIC grant in 2014; Hauge and her students presented their project at the MatRIC's first annual conference and an EVU conference (2014). The study was about collaboration between five master students and a lecturer. First, the collaboration was a partnership, with the common aim of conducting research. One of the two research areas of the project was mathematical modelling in a critical mathematics education perspective. Second, the collaboration itself was studied from an educational point of view. The collaboration was voluntary and not part of their master education. The second research area is thus on the significance of collaborative academic writing as an approach for teaching and learning. Hauge's report can be found at <http://www.matric.no/articles/30>. MatRIC has subsequently granted Hauge and her colleagues a new grant in 2015, which will continue to promote student-active learning approaches.

Said Hadjerrouit and Per Henrik Hogstad, University of Agder received a MatRIC research grant to explore how the mathematical visualization/simulation software (SimReal) developed by Hogstad for engineering students might be adapted to the needs of teacher education students. They undertook this as a collaborative research project in which the students were active participants in evaluating their learning in the context of the software. The first trial in 2014 revealed that the transition of learning resources from an engineering context to a teacher education context is far from trivial. The project motivated a follow-up study that built on what had been learned (also supported by a MatRIC research grant in 2015), and a masters dissertation study in which the teacher education master student explored the use of the software in the context of engineering students' learning.

Hadjerrouit's report from the 2014 research can be found at <http://www.matric.no/articles/26>.

Similar student based studies have been supported at Oslo and Akershus University College, and Østfold University College. Reports from these projects will be made available at [matric.no](http://www.matric.no).

A collaborative project between MatRIC and bioCEED was developed within the Mathematical Modelling Network. This has entailed mathematicians and mathematics education researchers working with biology undergraduate at the University of Bergen to develop mathematical modeling in the context of biological problems. Students are presented with authentic problems which they are expected to work on using mathematical modeling techniques – thus bring one research approach into their experience of biology and mathematics. A report of this project can be found at <http://www.matric.no/articles/58>.

b. How has the centre's development and enhancement of integrated models affected the students' learning outcomes?

An experiment in integrated learning is underway with the Electronics bachelor course, in this mathematics is integrated within the electronics content and the teacher (coordinator of MatRIC's video and digital assessment networks) is responsible for the mathematics teaching. For the

mathematics a flipped classroom approach is being adopted, and a special studio for recording instructional videos has been established. A new text book has been adopted which ensures mathematics examples are set within the context of the electronics subject studies. Initial indicators are positive, both in terms of student approval and performance.

4. Plan for 2016

Major externally focused events (4 symposium/colloquiums and one conference), together with the teaching course, setting up the Drop in mathematics support centres, development of the MatRIC web pages and MatRIC TV stretched human resources. 2016 will also be a busy year with visits both inwards and outwards to build MatRIC's international network, but a reduced programme of events (two symposiums/colloquiums and the conference). There will be some modest development of the web pages to accommodate requests from the video production group. The main objectives for 2016 are (these are not ordered by priority):

- To consolidate the developments that have taken place throughout 2014 and 2015, which, as shown above, address all the work packages and tasks set out in MatRIC's proposal.
- To continue to develop MatRIC Drop in and establish this as a sustainable and enduring part of the educational provision of the University of Agder; and to export the idea to other universities and university colleges. Student 'user groups' to advise on development will be set up.
- To continue to develop MatRIC TV into a valued open learning resource for mathematics students in Norwegian Universities and University Colleges.
- To develop more student involvement – in MatRIC's activities, and in their regular learning programmes – developing materials, peer mentoring, self-assessment, etc. One plan is to use (additional university) funding to appoint student tutor/mentors to support the electro course outlined above.
- To contribute to the development of teaching and learning across the university. A new university leadership team has been appointed (Rector, vice rectors, Director, Faculty Deans) that has declared itself to be dedicated to developing excellence in education. MatRIC will join in this challenge.
- To make a stronger input and impact in mathematics teacher education.
- At the time of writing MatRIC has three PhD fellows with Ministry of Education (KD) stipends and one Post-doctoral research funded by the Faculty of Engineering and Science at UiA. Applications for two new PhD fellowships (KD stipends) are presently being evaluated and we hope they will be in place from August.

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