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

Supplementary documentation requested by the NOKUT Evaluation Panel.

1. Project Plan. (*Extending the Centre description and time-line in first submission*).

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 authentic tasks for mathematical modelling.

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:

i. Networking mathematics teachers and users (engineers, scientists, economists, teachers, etc.).

ii. Coordinating research into innovation in teaching, learning and assessing mathematics.

iii. Developing teaching resources that simulate applications of mathematics in the workplace and a student laboratory for developing competencies in mathematical modelling.

iv. Disseminating research, innovation and excellence in mathematics teaching.

Realisation of MatRIC rests on four interconnected functions: 1.1 Management and administration; 1.2. Creation and maintenance of a national (and international) profile and presence; 1.3. Research and innovation; 1.4. Dissemination. Each function is outlined below, with milestones and deliverables.

1.1 Management and administration. MatRIC will have 3 organs with responsibility for the management and development of the Centre – A Management Board (CMB), An Executive (CE), An International Advisory Board (IAB).

The Centre Management Board (CMB) will be led by a Vice Rector of the University of Agder. Other members will include: Centre Leader, Dean of UiA Faculty of Engineering and Science, UiA teachers of Mathematics and user subjects, Student representatives, External members (Norwegian University of Science and Technology, Norwegian University of the Life Sciences).

CMB will be responsible for monitoring, policy, direction, reporting to NOKUT.

The Centre Executive (CE) will comprise the Centre Leader (50% position, Prof. S. Goodchild employed 100% at UiA), and a Centre Administrator (100% position, to be appointed).

CE will be responsible for leadership, administration, management of funds, implementing

CMB policy, regular reporting to CMB and IAB, collection and archiving of MatRIC records, products and data, maintenance of the Centre calendar, external communications and relations, facilitation of Centre activities (work packages), leading/supporting applications for external funding (Regional, national, European) to further the Centre's research and innovation.

The **International Advisory Board (IAB)** will include international and Norwegian individuals with extensive knowledge and experience of teaching and learning mathematics and user subjects in universities, leadership of Centres of Excellence, employer and professional organizations.

The IAB will be called on for advice and suggestions about policy and direction, and making judgments about the quality of the Centre's activities.

MatRIC's research and innovation workpackages will be undertaken by individuals and teams at UiA and other higher education institutions. *Initially* teams at UiA and NTNU will lead innovation in designing products for supporting teaching and learning. Initially researching educational outcomes of the innovative products will be led by the Mathematics Education Group at UiA. As MatRIC becomes established as a national resource, the aim is to bring teachers and researchers from other HE institutions into the Centre's activities, and to connect and support, innovation and research in mathematics teaching for user groups nationally.

Key milestones: Centre Leader confirmed in position by Faculty of Engineering and Science, UiA, and CMB established November 2013, first meeting December 2013. IAB established by the end of 2013.

Announcement of Centre Administrator position will be made December 2013, the post will be filled as quickly as possible. Temporary administrative assistance will be available until the Administrator position is filled. The Faculty of Engineering and Science, UiA will manage the appointment process within current university policies and practices and national regulations.

Deliverables: CE monthly reports to CMB and IAB. Effectiveness of activities 1.2-1.4 below.

1.2 Creation and maintenance of a national (and international) profile and presence. This will be achieved through the MatRIC web-site, e-mail, etc., a 'Start-up' seminar, and dissemination.

Key milestones: CE will call for tenders for the web-design November 2013. Centre web-site will be open autumn 2014. A temporary web-site will be established within the existing 'home pages' of UiA.

A Start-up seminar to explain the Centre plan and encourage participation in Centre activities will be held January 2014. The seminar will include exemplar activities and open discussion about the Centre's national contribution. Invited participants will include: Deans of Faculties of mathematics and user subjects and other stakeholders – professional and employer organizations.

MatRIC e-mail list including all interested in the work of the Centre will be created within the

first quarter 2014, social networking channels will be opened. A document archive will be created.

Deliverables: Centre web-site and communication channels; 'Start-up' seminar.

1.3 Research and innovation. These are described in the Centre Description as work packages 2 and 3. MatRIC will commission and publish a review of literature related to innovation and research in teaching mathematics to user groups at higher education, especially focusing on the use of video and emerging technologies. MatRIC will also carry out a survey of Norwegian (and Nordic) innovation and research within the interests of the Centre's network and facilitate communication between groups and individuals. MatRIC will also support the development of innovative simulation and modelling workshops in authentic contexts (e.g. in mechatronics, communications, health science, economics and finance, etc.) for teaching and learning mathematics.

Key milestones: Selection of researchers to conduct review and surveys (first quarter 2014), publication of results by December 2014. Establishment of working groups focused on innovation and research (1st quarter 2014). In year 1, researchers and teachers at UiA and NTNU will form the nucleus of these groups, wider national engagement will follow as MatRIC becomes known.

Negotiation of workplans of group coordinators. Creation of MatRIC calendars, agreements about administration, organization, activity, production goals and reporting. In addition to innovation, production and research, working groups will also develop workshops to disseminate their output.

Deliverables: Review of literature (12/2014). Survey of Nordic innovation & research (12/2014). First simulation workshop (12/2014); First modelling workshop (12/2014). Goal: to produce 4 new workshops each subsequent year, focusing on applications of mathematics in different contexts (engineering, finance and economics, health).

1.4 Dissemination. (more detail is included below, response to request for supplementary documentation point 3). Dissemination will be pursued by: communications network (web-site, e-mail, etc.); MatRIC publications (Newsletter, Journal); Meetings (MatRIC workshops & annual MatRIC conferences); papers in international journals, presentations at national and international conferences; visits to international centres of excellence of teaching and learning in mathematics, engineering, economics, etc.

Key milestones: MatRIC conference – programme committee set up (01/2014), first conference (12/2014). MatRIC Journal – Editorial board established (04/2014), first issue (11/2015).

Deliverables: MatRIC conference (12/2014, thereafter annually); MatRIC Journal (11/2015, thereafter annually – or more frequently if submissions demand); MatRIC Newsletter published two times each year: (June and December). Workshops will be organized at universities or university colleges around the country (normally two events each year).

2. Monitoring and measures of success.

Monitoring and evaluation

The Centre Executive will provide the Centre Management Board and International Advisory Board with monthly reports of activity mapped against the milestones and intended deliverables.

Qualitative feedback from individuals (teachers and students) who engage in Centre sponsored events will be collected, including reports of changes in practice arising from teachers' and students' participation in MatRIC activities. The Centre will use a web-based questionnaire (addressed to all stakeholders) to explore experiences, personal judgments, and suggestions.

Quantitative data of participation in the Centre will be collected: E.g. number of visits to the Centre web-site, participation in activities (innovation groups, workshops, conferences), visits to international centres, international visitors to MatRIC events.

MatRIC will seek and support case studies and vignettes of effective innovation in teaching and learning mathematics to user groups.

CE will prepare and CMB will publish an annual report of MatRIC activities and an analysis of the qualitative and quantitative data described above. IAB will be invited to make judgments about the quality of the Centre's activities and make suggestions for development and improvement. In the first quarters of 2015 and 2016 a small group from the IAB will be asked to prepare an evaluation of MatRIC for CMB. In 2017 NOKUT will undertake an evaluation. In 2018 the Centre will seek an external evaluation of the first five years.

Overall measures of success.

- Students' and teachers' reports of the impact and value of MatRIC's products, the usefulness of the Centre's network, and satisfaction with the Centre's organization and activities.
- Development of a research culture in mathematics teaching and teaching development.
- Development of teachers' research and inquiry in mathematics teaching in higher education.
- Nationwide engagement of university and university college teachers of mathematics and user subjects in MatRIC's network.
- Productions of simulations of mathematics and modelling workshops with mathematics applied in a broad range of authentic contexts. The goal is to produce resources and workshops that address mathematics in engineering; economics and finance; natural sciences; health; etc. (18 in the first five years).
- Implementation of the Centre plan and achievement of the milestones and deliverables.
- Generation of additional funding from regional, national and international sources to extend the Centre's programme of innovation and research.
- National (and international) reach of MatRIC Newsletter and Journal.
- Participation in and sustainability of the MatRIC conference.

3. Dissemination strategy

MatRIC will adopt a strategy in which dissemination evolves through three nested phases (Promotion, Profile and Product dissemination) in which both purpose and reach develop. Each successive phase builds on and incorporates earlier phase(s). In the 'Promotion Phase', which will coincide with the first year of MatRIC, dissemination will concentrate on making the Centre known and growing the network, regionally, nationally and internationally. Developing the network will continue as MatRIC enters the 'Profile Phase', in which attention broadens to develop the Centre's profile and making the Centre's resources – and resources of other groups and institutions associated with the Centre – known throughout the Centre's network. This second phase will extend through the second year of MatRIC and into the third year. MatRIC will aim to develop an international profile from the outset, especially through visits into the Centre and from the Centre to international centres of excellence (e.g Centre for Mathematics Education at Loughborough). However, as MatRIC enters the 'Product Dissemination Phase', it is anticipated that the resources of MatRIC, and the research base of MatRIC will both attract and deserve international attention, and the phase of product dissemination will commence.

MatRIC will use existing means and media for dissemination such as professional and scientific journals, conferences and interest groups, local and regional seminars and meetings, and national and international networks. In addition MatRIC will create and develop additional means to make the Centre known and disseminate the Centre's products, resources and output. These additional means include: MatRIC web-site, e-mail, (& other social networking); MatRIC Newsletter, and MatRIC Journal; MatRIC workshops, and MatRIC conference; and the Special Interest Groups developing modelling and simulation workshops based in authentic contexts. The MatRIC Newsletter will be produced by the Centre Executive, it will be in English so that the work of MatRIC can be followed internationally. The MatRIC Journal will provide a stepping-stone for university teachers in the MatRIC network to publish their work at an intermediate level within the Nordic community in the process of developing papers for existing international journals. MatRIC Journal will accept papers, following peer review, in English and Scandinavian languages.

Local dissemination, within the university. There exists an active seminar programme in mathematics education research. It will be natural to extend this to include MatRIC activities. The University of Agder (UiA) occupies two campuses separated by about 50 km. MatRIC will facilitate seminars at both campuses to embrace university mathematics teaching within all user groups (Engineering, Science, Economics, Health Care, Teacher Education). MatRIC will be active to promote its work and potential within the university by creating opportunities to explain the activities within regularly held Department and Faculty meetings (across the university), explore new possibilities and encourage participation within the MatRIC network. MatRIC will also take

advantage of the opportunities to extend its reach within the university through the university's Educational Development Centre by offering courses in innovative teaching with video and emergent technology.

Regional dissemination. MatRIC will work with mathematics and other subject specialists to develop links with users of advanced mathematics, mathematical modelling and simulation. MatRIC will seek collaboration with specialists in (engineering enterprises, hospital and health care, research institutes, finance industry, etc.) – to develop modelling and simulation applications of mathematics in authentic contexts. *An aim will be to explore ways in which MatRIC can develop resources that will better motivate and prepare students in their studies and future careers*.

MatRIC workshops will be held at the University of Agder and other universities/university colleges. Workshops will aim to have a regional as well as local impact and potential user groups from enterprises relevant to the workshops will be invited to participate. MatRIC will exploit the synergy that exists between engineers, scientists and academics etc. for educational (and professional) development. The participation of people from enterprises, businesses and research institutions will enhance the Centre's activities and open up new opportunities to develop authentic simulations and modelling opportunities.

There already exists within the region an 'MNT Forum' (Mathematics, Natural Sciences, Technology) that brings together university teachers and upper secondary school teachers, and representatives from the local authority and local businesses and industries. The meetings and visits of the Forum are used to develop regional awareness of cutting edge applications of science and technology. MatRIC will contribute to the MNT Forum and use the Forum to disseminate the work of the Centre, to 'show case' Centre products and to develop links with outside organizations.

National dissemination. Promoting the Centre and developing national participation in the network will have a high priority from the outset. The national network, identified as work package 1, is crucial to the success and impact of MatRIC. MatRIC will organize a 'Start-up' Seminar to explain the foundation and goals of MatRIC and further explore opportunities for collaboration. Deans of Faculties where teachers will benefit from being in the MatRIC network will be invited (or send a substitute). Other national stakeholders will also be invited.

MatRIC will also seek, through personal contact and visits, to develop links with other national centres of excellence in both education and research. These links will be important, to inform about the activities of MatRIC, to engage others in the MatRIC network, and to learn from good practice.

The annual MatRIC Conference, MatRIC Newsletter and MatRIC Journal will create opportunities for national dissemination. International guest speakers will be invited to the conference, and react to papers published in the journal. It is hoped that the conference and

publications will also attract international participation, especially from the Nordic countries.

International dissemination. MatRIC will seek associate membership of the European Society for Engineering Education (SEFI, http://www.sefi.be/) and benefit from the existing SEFI network.

The front pages and much of the MatRIC web-site will be in English to encourage international attention, although contributors to the web-site and journal will be able to write in a Scandinavian language if preferred (brief English summaries of Scandinavian text will be included).

MatRIC will support members of the network to visit international centres, to learn from good practice and make contact with others working on similar teaching and learning projects. MatRIC will also support visits of leading international teachers and scholars to share in MatRIC activities.

MatRIC will use the opportunities of international conferences to disseminate the activities and output of the Centre. Specialist conferences in engineering education, economics education etc. will be used. Research and evaluation of teaching resources developed through MatRIC will also be submitted to international journals.

Conferences (there are numerous, some examples are listed):	**Journals (there are numerous, some examples are listed):**
European Distance E-learning Network (EDEN)	Int. Journal for Technology in Education
Int. Symposium on Problem Based Education	Int. Review of Economics Education
European Society for Engineering Education (SEFI) Conference	The Journal of Economic Education
(& SEFI Mathematics Working Group: http://sefi.htw-aalen.de/)	Int. Journal of Engineering education
Int. Group for the Psychology of Mathematics Education	Int. Journal of Mathematics Education in Science and Technology
Congress of European Researchers in Mathematics Education	Int. Journal of Science and Mathematics Education
Nordic Researchers Mathematics Education Conference	Studies in Higher education
Int. Conference on Technology in Mathematics Teaching	Teaching Mathematics and its Applications
Int. Society for Design and Development in Education	Int. Journal of Electrical Engineering Education
	Computers and Education
	British Journal of Educational Technology
	Engineering Science and Education Journal
	European Journal of Engineering Education

4. Collaboration with NTNU.

MatRIC will have a national profile that facilitates networking, collaboration and dissemination of innovation and research in teaching and learning mathematics within user programmes. In Norway, The Norwegian University of Science and Technology (NTNU) is the leading technological university and is investing heavily in developing and researching approaches using multimedia based technology in teaching and learning mathematics and other subjects. Teachers and developers at NTNU are creating high quality educational videos on specific subject topics and researching the factors that impact upon the videos' effectiveness in teaching and learning. There is considerable complementarity and some duplication of effort in mathematics teaching through video at NTNU and UiA, and thus scope for collaboration and synergy. MatRIC will be keen to support the national networking of teachers with NTNU and other universities and university colleges and the dissemination of teaching products and research into the use of these multimedia products.

MatRIC will provide the context and release resources for collaboration between mathematics teachers at UiA and NTNU, and because of the critical mass they produce others will want to participate. Innovative teachers of mathematics, science and engineering, and researchers in mathematics education at UiA and NTNU are seeking opportunities to collaborate to form the nuclei of several interest groups focusing on producing and researching the effectiveness of a diversity of resources for teaching, learning and applying mathematics with emergent technology.

- MatRIC will support the development of a special interest group that focuses on the innovation and research in using multimedia technology in teaching and learning mathematics. MatRIC will contribute towards travel and subsistence of teachers engaged in and wishing to develop similar teaching products from other institutions to meet and collaborate with the NTNU team.
- At UiA and NTNU mathematics teachers have experience of working with computer simulations of mathematical concepts to support teaching and learning, and there has been some exchange of ideas. The existence of productive divergent thinking between the UiA and NTNU groups will result in creative engagement and both groups are looking forward to the opportunities for collaboration in this development that will be opened up by MatRIC.
- MatRIC will support research, complementary to that already proposed and pursued by teachers and developers at NTNU into the use and effectiveness of multimedia based technology in teaching and learning mathematics.
- MatRIC will provide opportunities for the dissemination of innovative products and research evidence within the Norwegian community (MatRIC Newsletter, MatRIC Journal, links from the MatRIC web-site).
- NTNU will be represented on MatRIC Management Board. (Professor Frode Rønning, Professor of Mathematics and Mathematics Education at NTNU).

Professor Berit Johanne Kjeldstad, Pro-Rector (Pro Vice Chancellor) at NTNU, with special responsibilities for educational matters writes as follows: “I fully support the initiative taken to establish collaboration between NTNU and the University of Agder in the proposal to establish an SFU based on the MatRIC project. The responsible unit at NTNU to follow up the project will be the Faculty of Information Technology, Mathematics and Electrical Engineering represented by the Department of Mathematical Sciences.”

Through networking and other means MatRIC will seek to support and disseminate innovation and research in teaching mathematics to engineers, economists, scientists etc. that are being carried out in all Norwegian institutions of higher education. MatRIC will only seek acknowledgement when the Centre has provided substantial support, it will not claim ownership of products. It will be the aim of MatRIC to recognize and promote innovation and research and direct to expertise and centres of innovation and research in teaching mathematics for the benefit of teachers and students in Norway, Scandinavia and internationally. Intellectual property rights will remain with the authors and originators of research and developments, but a condition of receiving Centre support will be that products supported by the Centre will be freely available.

5. Evidence of existing expertise in innovation and research in using digital and video simulation packages.

Examples of web-sites

Per Henrik Hogstad

http://grimstad.uia.no/perhh/phh/ (web site in Norwegian)

Cornelia Brodahl

http://home.uia.no/cornelib

Examples of publications:

Brekke, M. (2013). Early testing of e-exams in calculus at university level. *Proceedings of the European Distance and E-Learning Network Annual Conference, "The Joy of Learning: Enhancing Learning Experience - Improving Learning Quality"*. Oslo, 12-15 June,

Brekke, M., Hogstad, P. H. (2006). SimReal, et interaktivt arbeidsverktøy i fysikk, matematikk og statistikk. Det virtuelle laboratorium til bruk i parAbel (SimReal an interactive tool in physics, mathematics and statistics. The virtual laboratory used in parAbel). *NVU konferansen 2006, 'En ny hverdag - nye utfordringer'.*; 13-14 March.

Brekke, M. & Hogstad, P. H. (2010). New teaching methods - Using computer technology in physics, mathematics and computer science. *International Journal for Digital Society*, Vo1. 1 pp.17-24. http://www.infonomics-society.org/IJDS/Contents%20Page%20Volume%201%20Issue%201.pdf

Brock, S. & Brodahl, C. (2013). A Tale of Two Cultures: Cross Cultural Comparison in Learning

the Prezi Presentation Software Tool in the US and Norway. *Journal of Information Technology Education: Research, 12*(1), 95-119. http://www.jite.org/documents/Vol12/JITEv12ResearchP095-119BrockFT53.pdf

Brodahl, C., & Oftedahl, H. (2012). Outsourcing Systems Development for e-Learning Applications. *International Journal on E-learning, 11* (1), 5-22.

Brodahl, C., Hadjerrouit, S., & Hansen, N.K. (2011). Collaborative Writing with Web 2.0 Technologies: Education Students' Perceptions. *Journal of Information Technology Education, 4*, IIP73-IIP103.

Flens, M. & Vos, P. (2013). Designing Video Instruction for Mathematics. In A.M. Lindmeier & A. Heinze (Eds.), *Proceedings of the 37th Conference of the International Group for the Psychology of Mathematics Education, Vol. 5* (p. 57). Kiel, Germany: PME.

Hogstad, N. M. (2012). *Bruk av SimReal+ i matematiske fag på universitetsnivå. En case-studiet av studenters holdninger og utfordringer [Use of SimReal+ in mathematics at university level: A case study of students attitudes and challenges]*, december 2012. Unpublished masters dissertation, University of Agder.

Vos, P. (2011). What is 'Authentic' in the Teaching and Learning of Mathematical Modelling? In G. Kaiser, et al (Eds.), *Trends in Teaching and Learning of Mathematical Modelling* (pp 713-722). New York: Springer.

Vos, P. (2011). Design principles for digital modules for Advanced Mathematics that cater for both procedural fluency and conceptual understanding. *Conference on E-Learning and Mathematics, Eindhoven University of Technology.*

Vos, P. (2010). Designing e-learning for Advanced Mathematics; Emphasis on Procedural and Conceptual Knowledge. *Invited Lecture. Masters course Research in Mathematics Education, University of Utrecht, 24 September*.

Vos, P. (2009). E-klassen bij wiskunde D [E-learning in Advanced Mathematics]. Keynote speech. Landelijke Wiskunde D Dag [National Mathematics D-Day], Commissie Toekomst Wiskundeonderwijs (cTWO), 5 june.

Vos, P. (2007). Assessment of Applied Mathematics and Modelling: using a Laboratory-like Environment. In W. Blum, et al. (Eds.), *Applications and Modelling in Mathematics Education; New ICMI Studies Series no. 10* (pp. 441-448). New York: Springer.