

A NEW INTRODUCTION TO A MASTER PROGRAMME IN MATERIALS SCIENCE, TURNING STUDENT DIVERSITY INTO AN ADVANTAGE

Maria Knutson Wedel

Henrik Persson

Chalmers University of Technology
Gothenburg, SWEDEN

ABSTRACT

The paper describes how diversity problems were identified and addressed in a Master's programme in Advanced Engineering Materials, and how organisation of a programme according to CDIO has been found to facilitate the process of organising teaching and learning to take advantage of cultural diversity. By comparing with experiences from literature, we find that our international students need to blend into an already existing group. We aim for them to be met by clear expectations and information, in an atmosphere within which students, no matter of their background, feel they have something significant to contribute. Important is pre-entry information, e.g. on course choice and on subjects and skills covered previously and to introduce our different perceptions of learning. Some international students have deep knowledge in subjects we do not teach; design of a new learning activity aimed for all students to benefit from that knowledge and to train the role of materials specialist. The paper describes in detail how needs were identified by a survey answered by students already participating in the programme (pre-project survey). It also describes a new introduction that has been designed to meet the challenge of diversity. Pre-entry information, a welcome letter, an interactive homepage and activities were designed to allow for multicultural discussions and nurture a feeling of having something significant to contribute. A new experimental learning experience was developed centred on a product and managed by peer learning. Finally the evaluation of the project is described including a survey answered by the students who participated in the introduction (post-project survey).

KEYWORDS

CDIO, education development, diversity, peer learning

INTRODUCTION

Chalmers University of Technology in Gothenburg, Sweden, has since 2007 and the start of about forty international master's programmes, become increasingly diverse in the educational perspective. Ethnicity is one aspect; the students are also diverse in terms of English proficiency, study culture, and educational background. The driving force for internationalization is to prepare the students for a global market and in addition it is expected that diversity experiences would be positive for learning outcomes [1]. However, the students with a BSc

degree from Chalmers have developed a familiarity with the workings of the university; they have peer networks and possess similar expectations of their university studies. Comparable to the situation for our international students, it has been shown for direct entry students in the UK who are expected to effectively make the change from further to higher education and *blend into an already developed group* that it can be a *stressful transition* [2]. The UK Student Progression and Transfer (SPAT) Project 2004 showed that students entering the education later specifically raised the issues of *pre-entry information, early information on module choice, different teaching styles and class size, availability of information on subjects covered in previous years of the course, skills - particularly essay writing and exam technique, and financial implications of further study* [2].

In addition, it has been identified a variety of other learning issues upon joining an existing group. A feeling of isolation can be brought about by a sense of being out of place in the new learning environment with no recognizable peer group with which to identify [3]. It has been reported that international students are particularly vulnerable and suggested that strategies such as *pre-semester bridging programmes* should be helpful in assisting with social integration and feelings of belonging to the university [2]. Others claim that active participation through *class discussion in a multicultural classroom* provides the best lessons in cultural diversity and how to recognize and respect each other. Discussions provide opportunities to learn from differences and achieve cultural synergies which would be a positive experience for all [4]. Unfortunately, international students could be used to a teacher-centred and lecture based study culture and might feel uncomfortable when exposed to active learning and teamwork in the class-room [5][6]. Flowerdew and Miller [7] who studied cultural diversity while teaching Chinese students in Hong Kong, found a *discrepancy in student and lecturer perceptions regarding purposes of lectures, roles of lecturers, styles of lecturing, simplification, listener behaviour and humour*. They recommended that actions to be taken should include possibilities to increase understanding of each other's perception. Peer learning, as long as it is accompanied by feedback and proper assessment, is regarded to be such a learning activity where communication and understanding is brought forward [8].

In our case, which is a Master's Programme in Advanced Engineering Materials (MPAEM), course evaluations from previous years have indicated that diversity among the students has posed some difficulties, especially during the first semester. The programme has a number of 20-30 students entering each year, an additional 5-8 Erasmus students choosing all courses and up to 30 Swedish Chalmers students taking a few of the courses in the programme. The result is a mix of about 50/50 international/national students, highly varying depending on admission year and course. Furthermore, the students have different bachelor exams; in mechanical engineering, metallurgy, polymeric engineering, materials science, chemistry or physics. The diverse student background is something we aim for, materials science being a discipline with research performed within departments of material science as well as chemistry, physics and mechanical engineering. An additional complication is the varying pre-knowledge and skills in generic competencies, such as teamwork, communication or engineering for a sustainable society. The Swedish students from the CDIO based mechanical engineering programme are superior in that sense.

By comparing our case with the experiences above, our reflections are that our international students need to *blend into an already developed group*. We have to aim for them to be met by clear expectations and information, communication in an open welcoming atmosphere within which students, no matter of their background, feel that they have something significant to contribute. They might feel a need of pre-entry information, early information on course choice, and on subjects covered in previous years as well as skills - particularly essay writing and exam

technique. We also need to address our different perceptions of teaching styles and class size, purposes of lectures, roles of lecturers, styles of lecturing, and listener behaviour. In addition, we believe that very little is discussed regarding how diversity could be used as an advantage. Some of the international students have deep knowledge in subjects we do not teach in compulsory courses and by good design of learning activities all students could benefit from their knowledge. By taking the role of a specialist in a group activity they will also train an engineering skill, the material specialist role in a team. Many of the suggestions found above relate to early activities and we thus aim to design an introduction to the master programme, where as many as possible of the goals can be met.

The CDIO concept provides many possibilities for solutions to our stated aim above by the inherent idea of integrating learning of skills and active learning centred round a product or process [9]. In addition the master's programme is already CDIO-inspired [10]. Existence of a programme design matrix, clear learning objectives and assessment are of help for students in need of information regarding required pre-knowledge as well as those wondering about the study culture. Product centred active learning leaves room for multicultural discussions where lecturers can organise opportunities for students to explore each other's different perceptions. Organisation of a programme according to CDIO thus facilitates the process of organising teaching and learning to take advantage of cultural diversity. Additionally feedback to make sure that we mean the same thing would be more crucial than ever. It would be equally important to organise for enough time for reflection and learning in a foreign language.

The current paper describes how the problems of diversity were met by a reformed introduction to the Master's programme of Advanced Engineering Materials. The basis for reform was the stated aim above, experiences of the students in the programme and CDIO based learning activities. The reform incorporated learning activities where diversity was used as an advantage. The paper is outlined as follows: First we describe how needs were identified by a survey answered by students already participating in the programme (pre-project survey). Then we describe the welcome letter and the design of an interactive homepage which made it possible to attain the goal of supplying pre-entry information and for new students to identify strengths or weaknesses. In a third part we describe the activities during the new introduction week, designed to spark multicultural discussions and nurture a feeling of having something significant to contribute. A new experimental learning activity was developed centred on a product, applying the knowledge of materials as well as characterization methods and managed by peer learning. Finally we describe the evaluation of the project including a survey answered by the students who participated in the introduction (post-project survey).

THE PREPARATION OF THE NEW INTRODUCTION

The planning of this project consisted of collecting as much information as possible regarding the nature of the problems of diversity, through literature and experiences from students and faculty using both a survey and results gathered from course evaluations and programme evaluation. It was decided that a more extensive introduction could be a solution.

Results from student pre-project survey

A survey was sent to all current students in the master programme to have their needs addressed, receive their opinions on possible activities and capture novel ideas on how to meet our new students.

They were all, both Swedish and international students, convinced that their pre-knowledge was enough. The previous introduction made them all feel welcome. On the question regarding their opinions on pre-entry material, self-test questions was most popular, see Fig. 1, followed by “Summaries and study material in important areas”.

The suggestions from the students were many. The previous introduction consisted only of meeting with information and lunch, an ice-breaker activity for a couple of hours and two crash course lectures in material science. Keeping the already existing ice-breaker activity and the lectures was important according to the students. In addition the students asked for more social activities, practical classes and group work in the beginning, communication with people from industry and research, information on course selection, plagiarism and Swedish culture of writing essays. This is to a large degree similar to the wishes from direct entry students in the UK [2].

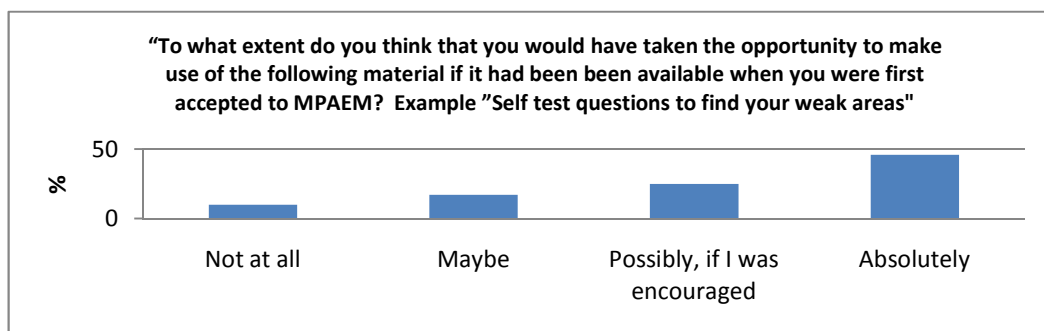


Figure 1. Result from pre-project survey

Allocation of time in teaching schedule

We decided to keep the introduction within the first semester and to make it compulsory. One of the lecturers changed his course and cancelled the lectures during the first week (out of a seven week course) which allowed room for introduction activities.

PRE-ENTRY ACTIVITIES

The new programme introduction consists of pre-entry activities which precedes an introduction week.

Welcome letter

An individual welcome letter was sent out as soon as the admission procedure was finished in June for the international students; the Swedish students got their letter later due to the later admission procedure. The purpose was to make the students feel welcome and give them the link to the recently created interactive homepage. They were all given temporary usernames and passwords to be able to log on to the University student portal.

New interactive homepage

An interactive homepage was created at the University student portal (trade-name PING PONG). The purpose was to facilitate for the students to identify their strengths and weaknesses

in relation to the programme learning objectives and the expected level of proficiency in materials science. In addition this would be a way to establish an early connection to the newcomers.

On the homepage we created a self-test covering different areas of materials science which we teach our Chalmers students in mechanical engineering. In addition we attached recommendations of a good basic book in Material Science accompanied with reading instructions and links to good interactive websites. It was clearly stated that the basic knowledge would be reviewed again during the introduction week, but if the students identified weaknesses during the self-test it was possible to prepare for the programme start, using the instructions on the website.



Figure 2. The interactive homepage

INTRODUCTION WEEK

Social and learning activities were created for every student to make use of their specific knowledge and make them acquainted with our culture of learning. To start with, practical information took place for all students (about 30) and we formed six *groups of students with diverse background*. An introduction to *group dynamics* was included. *Presentation of the programmes lecturers* and the coming compulsory courses was made during a lunch arranged by us.

The ice-breaker

We had an ice-breaker activity previous years, but it was this year extended and enlarged. On day one "*Rädda Ägget*" (*Rescue the egg*) took place. The intention, in addition to "break the ice", was that groups would form, where students would know each other well enough to be able to communicate during the peer learning activities later on. For "Rescue the Egg" the students had

one hour to build a vehicle/design/device that would allow a raw egg to fall from a height of 10 m without being destroyed. The activity took place inside “Kopparbunken” (The Copper Bowl); our high voltage lab which is a copper-clad Faraday cage building. They had a limited amount of material to choose from, scrap which we had retrieved from the garbage room. The criteria for success were speed, sound engineering and design, evaluated by two judges; one professor and one study secretary. It was combined with a presentation by our group in High Voltage Engineering who created a HV-flash as well.

Social activities

Swedish “*Brännboll*” (national sport somewhat similar to softball) was arranged in the early evening in the nearby park with a picnic for those who wished to take part in that. It was an opportunity to get to know each other and also to discuss national sports.

The crash course

Day two and three contained *introductory materials science lectures*. During the lectures the students experienced active learning and were introduced to our Swedish culture where students are encouraged to talk and interact during lectures. They built (111)-crystal planes to understand crystal structures in metals. The students were told to perform the building activity in their groups and help each other. Some of the students had deep knowledge in crystal structures and they were encouraged to share their knowledge. Others were shown that there are many students that find it difficult with 3D-geometry in crystals and they were encouraged to voice their concerns, no matter of how basic the questions were.

The product centred experimental learning activity; “The MIP”

On days four and five a new learning activity, “*The MIP*” (*Materials In a Product*), took place. The learning objectives include developing skills on how to identify materials, how to choose material for a product regarding price and product performance and how to participate in active and peer learning. The MIP also provides active discussion in a multicultural classroom where the students can compare how they have been taught materials characterisation in their earlier studies. The learning activity also gives a possibility to make use of diversity. Since the students were divided into “multidisciplinary” groups based on the strengths of their respective bachelor programme, they had ample opportunities to learn from and develop respect for each other. The assignment made it necessary for them to rely on their respective strengths and made it possible to practice the specialist role of the materials engineer.

During the MIP the students in their six multi-disciplinary groups were given a razor (each group a different one; three intended for ladies and three intended for men). Two were extremely cheap, two medium and two were expensive razors. The assignment was to suggest a procedure of experiments to identify all materials in the razors and then perform the experiments and identify the materials during one day. The work led to intensive discussions regarding experimental techniques and how to analyse the results, see Figure 3. Finally, during the follow-up next morning the groups were mixed resulting in new groups consisting of members from all initial groups. The follow-up assignment was to compare the razors and identify whether and how the materials selection and processing were coupled to price and design.

During the whole procedure, teaching assistants (PhD students) were available for help during the performance of the experiments. If anything was suggested that was not available, feedback was given to tell whether it was a good idea or not and the reasons why it was not available. The

students were told that they would have to take responsibility depending on their individual strengths and act as *peer instructors* to the rest of the group members. In the end, during the follow-up, all members of the group had to be able to present and discuss their razor with representatives from the other groups. The teaching assistants did not answer direct questions on which material it was but gave feedback to the students in their discussions.



Figure 3. Intensive work during the MIP learning activity

Contact with industry and research

During the week a *guest lecture from industry* on the professional role of materials engineers was included as well as informal *presentations of the research* in the department. The purpose was to show the students the connection to industry and research and to give them an overview of the strong research areas of the department.

EVALUATION OF THE PROJECT

The pre-project survey and the suggestions from the students already participating in the programme were very useful. It reassured us that we, in preparing the new introduction activities, were thinking in similar direction as the students regarding their needs and how those could be addressed. In addition the students for instance showed that they were very interested in the research at the department.

The pre-entry activities were a success from many perspectives. It was possible to follow the log on the homepage. Aiming for a 50/50 (international/national) mix of students, 15 national and 36 international students were admitted (usually about 40% of the international students arrive at Chalmers). Out of the 51 admitted students, 25 had logged in which is about 50%. The list of admitted Swedish students and their e-mail addresses was received later and these students did not get their welcome letter and login information until one week before the start of the first semester which was not optimal. The absolute majority that logged in were thus international students.

The self-test was a key if students in advance were to know which strength they could contribute in group assignments. 20 students opened the quiz, 9 performed all of the test-questions with a success rate of 60-80%. The purpose was for them to get a grasp of the expected level of proficiency in different areas. The student post-project survey showed that rather few students of those answering the survey, 30%, actually had done the self-test, but the ones who did thought it was a good tool to find their weaknesses and strengths.

An unexpected result from the pre-entry activities was that the number of admitted international students that actually arrived at Chalmers was increased substantially – 61% compared to the earlier 40% (track record since twenty years). It was a strong correlation between who of the students that had logged into the homepage and who arrived; all logged in arrived, except one. The intended communication was established and the number of student e-mails to the programme director increased substantially. Both the survey and the statistics from the homepage show that there is a link between retention and pre-entry activities; 50% of the students said that the welcome letter and the interactive homepage contributed to a large extent or a very large extent to their choice of coming to our programme, see Figure 4.

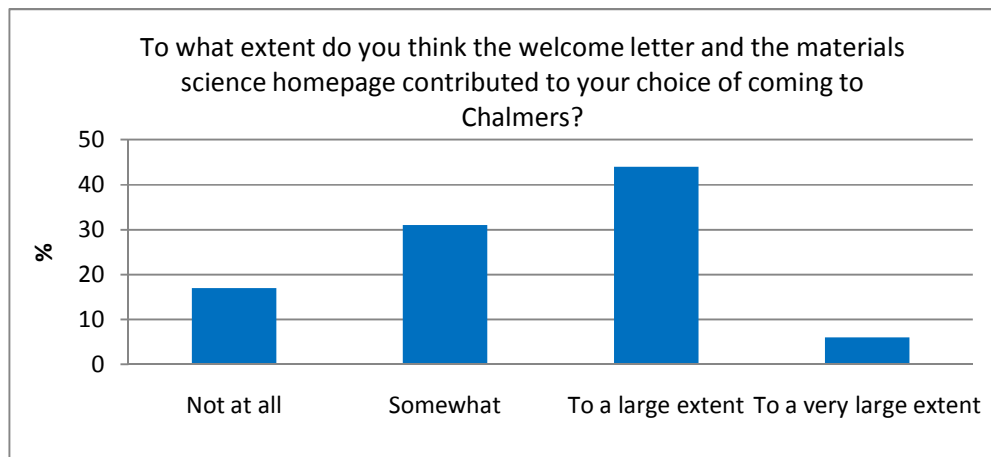


Figure 4. The role of pre-entry activities for the decision of entering the programme

The development of the MIP is an important addition to the learning activities in MPAEM, being active, performed by peer learning, correlated to their professional role as materials engineers and giving the opportunity for students with specialist knowledge to share that with other students. 100% of the students attended "Rescue the Egg" and MIP and the survey showed that these were the most popular activities. The general opinion of the "Rescue the Egg" activity was that it was fun, a good way to get to know the new classmates and that it was a good activity to improve the future teamwork of the group. The main comments on the MIP was that the students learned new things about materials and material testing methods (mainly regarding polymers) and that it further improved their teamwork skills. The follow-up assignment where the groups were all mixed was considered to be interesting. The students realized the relation between the price of the material and the quality of it and noticed that the different groups had used different reasoning but same experimental techniques to characterize the materials. Most of the students also felt comfortable presenting their own results to the new group. Our impression, after interviewing the teaching assistants, is that the students had very early formed their groups. The discussions that we overheard during the peer learning in the MIP class were on a very good level and in general the students could contribute their specific knowledge as intended to.

The introductory lectures on a basic level of materials science were attended by about 50-60%. The survey showed that the lectures were considered to be a rewarding activity and most students thought that it was on the right level of difficulty. About 50% also attended the information from the research groups.

The overall result was satisfying. From the student post-project one could see that the students were overall very satisfied with the introduction (welcome letter, interactive homepage and the introduction week), see Figure 5. Over 90% of the students answered that they were satisfied to a major extent or completely satisfied with introduction.

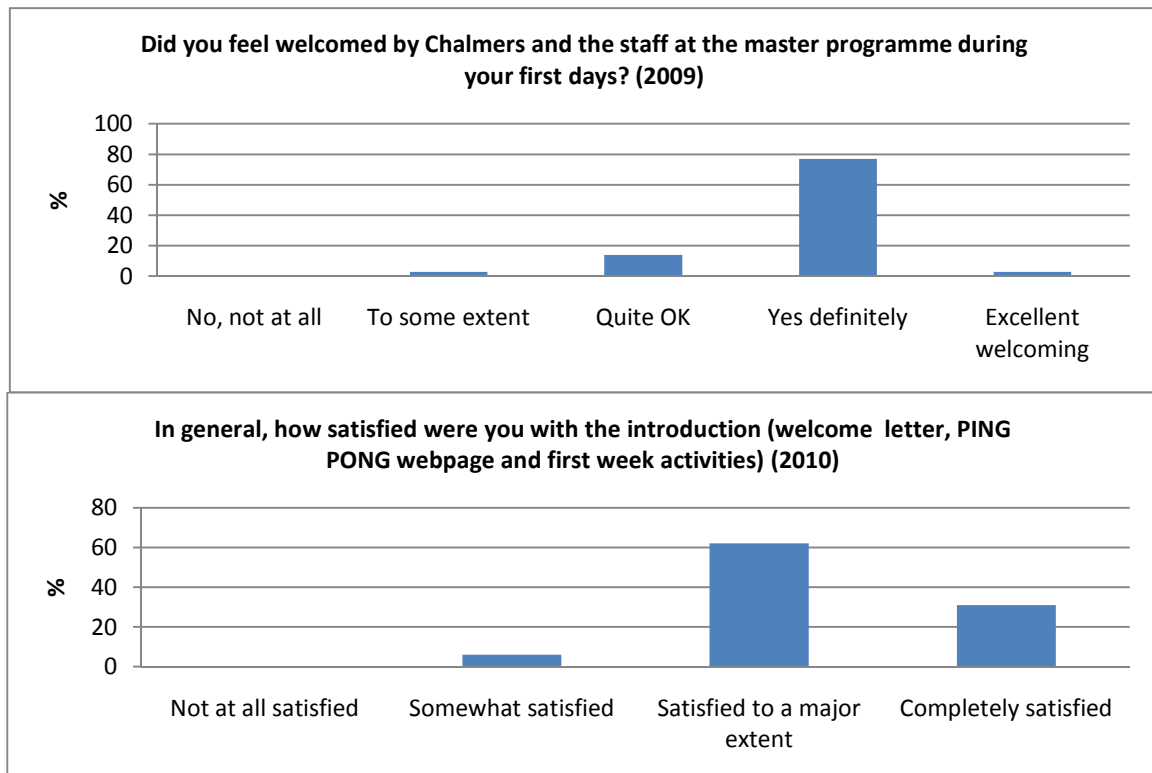


Figure 5. The impression of the first week of the master programme before and after the new introduction, from pre-project and post-project survey. (The question isn't identical though)

CONCLUSIONS - RECOMMENDATIONS FOR THE FUTURE

Diversity issues have been analysed for an international Master's Programme in Advanced Engineering Materials. By a literature review and surveys we have found that

- our international students need to blend into an already developed group and thus need to be met by clear expectations and information, communication in an open welcoming atmosphere within which students, no matter of their background, feel that they have something significant to contribute
- pre-entry information, early information on course choice, and on subjects covered in previous years as well as skills - particularly essay writing and exam technique are needed

- different perceptions of learning need to be addressed
- many of the suggested solutions to address diversity call for activities as early as possible at entrance to the programme
- organisation of a programme according to CDIO facilitates design of teaching and learning activities to address cultural diversity

Based on the findings above, we have designed a new introduction to the master programme, where as many as possible of the issues can be addressed. The introduction includes pre-entry activities and activities during the first week of the first semester. We have shown that a learning activity could be designed where diversity is an advantage and where students train the material specialist role in a team.

In general the situation for the students was improved. Pre-entry information was created and students appreciated it. Groups were early formed and friends were made. We made use of various pre-knowledge by a stepwise process where students could identify their strengths and were able to contribute those in a peer learning process centred round a product in groups. Our culture was encountered early on and students had the possibility to discuss their various perceptions of learning.

An additional result was that a homepage like ours can actually help to estimate the number of admitted students that arrive and facilitate the work of placing the students in groups in advance as well as increase retention.

For further work we have identified several tasks. We need to address the issue of different perception of what a good written report is, varying training of engineering skills in different programmes and what plagiarism means in different cultures. We also should address how to prepare for exams and the role of group projects run in parallel with lectures. Many of these issues take time to reflect on and need to be addressed timely during writing of reports and should be discussed continuously. Furthermore, many international students still find the language a barrier; a majority of the lecturers and the students speak English as a second language. There are also a number of ways to further improve the homepage. One suggestion is to create chat rooms where the new students can communicate with each other in advance.

ACKNOWLEDGEMENTS

IMPACT at Chalmers University of Technology, an initiative for pedagogical development of master programmes 2007-2009, is thanked for the financial support of this project.

REFERENCES

- [1] Gurin, P., Dey, E. L., Gurin, G., Hurtado, S., "The educational value of diversity". In Gurin P., Lehman, J.S., Lewis, E. (eds.), Defending diversity: Affirmative action at the University of Michigan, Ann Arbor: University of Michigan Press, 2004, pp. 97–188.
- [2] Barron P., D'Annunzio-Green, N., "A smooth transition? Education and social expectations of direct entry students", Active learning in higher education, vol 10, 2009, pp. 7–25.
- [3] Trim, P.R.J., "An Analysis of a Partnership Arrangement Between an Institute of Further Education and Institute of Higher Education", Journal of Further and Higher Education, vol 25, no 1, 2001, pp.107–16.

- [4] DeVita, G., "Inclusive approaches to effective communication and active participation in the multicultural classroom: An international business management context", Active Learning in Higher Education, vol 1, 2000, pp. 168-180.
- [5] Pun, A.S., "Managing the Cultural Differences in Learning", Journal of Management Development, vol 9, no 5, 1990, pp. 35–40.
- [6] Chalmers, D., Volet, S., "Common Misconceptions about Students from South-East Asia Studying in Australia", Higher Education Research and Development, vol 16, no1, 1997, pp.87–98.
- [7] Flowerdew, J., Miller, L., "Lectures in a Second Language: Notes Towards a Cultural Grammar", English for Specific Purposes, vol 15, no 2, 1996, pp. 121-140.
- [8] Boud, D., Cohen, R., Sampson, J., "Peer learning and assessment" , Assessment and Evaluation in Higher Education, vol 24, no 4, 1998, pp. 413-426.
- [9] Crawley, E. F., Malmqvist, J., Brodeur, D. R, Östlund, S. Rethinking Engineering Education – The CDIO Approach, Springer-Verlag, New York, 2007.
- [10] Knutson Wedel, M., Malmqvist, J., Goodhew P., "CDIO Applied in the Context of Materials Science" In Proceedings of 3rd Annual CDIO Conference, MIT, Cambridge, Massachusetts June 11-14, 2007 (on CD or www.cdio.org)

Biographical Information

Maria Knutson Wedel is Professor in Engineering Materials, Director of the Masters Programme in Advanced Engineering Materials and member of the pedagogical committee at Chalmers University of Technology, Gothenburg, Sweden. Her research is focused on characterization of engineering materials regarding the correlation between microstructure and mechanical properties and cross-disciplinary research on materials response to microwaves in recycling technology.

Henrik Persson is Licentiate of Engineering in Materials Science and a PhD Student at the Department of Materials and Manufacturing Technology at Chalmers University of Technology, Gothenburg, Sweden. His current research focuses on cable semiconductive compounds based on carbon nanodisks.

Corresponding author

Professor Maria Knutson Wedel
Department of Materials and Manufacturing Technology
Chalmers University of Technology
SE-412 96 Gothenburg, SWEDEN
+46 31 772 15 33
maria.wedel@chalmers.se