COGNITIVE, SOCIAL AND EMOTIONAL ASPECTS OF INTERDISCIPLINARY LEARNING

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ABSTRACT

The aim of the Joint Interdisciplinary Project (JiP) is to prepare Master students for their entry into the workforce after their study. In JiP they will contribute to solving impactful, real-life technological challenges provided and supervised by renowned companies. Interdisciplinary student teams are guided by a company coach and are offered academic and industry expertise. These projects not only demand good engineering working knowledge but also a solid grounding in interdisciplinary and systems thinking, and both knowledge and mindsets of innovation and entrepreneurial behaviour. The curriculum of Jip was designed to deliver this. The current study aims to evaluate the curriculum design with a pre and post-test survey amongst students about their, cognitive, social and emotional expectations and challenges in interdisciplinary working and the highlights of the learning process during the programme.

KEYWORDS

Interdisciplinary Learning, Learning dimensions, Engineering Higher Education, Learning Approaches in an Engineering Context, Curriculum Design, Standards 8,11,12

INTRODUCTION

Kamp (2019) in his work, has already shown that many industry experts and leaders in innovation found the knowledge and skills of most graduates are not broad enough and not adapted to the digital transformation taking place. "*Many young graduates who enter our workforce after their study at a university have a good theoretical understanding of the fundamentals, but little idea how business works and what engineering practice is about".* The primary value and function of an engineering professional are to go beyond the acquisition of knowledge towards the application of knowledge (Miller, 2018).

The ultimate purpose of the Joint interdisciplinary Project for students is to come up with an innovative design /research with a sustainable impact on society and added value for the company within a period of 10 weeks. The brief with the problem is related to minimally 2 of the sustainable development goals (SDG) and solved in an interdisciplinary team of engineers, designers and scientists. The company aims to find new commercial applications and business models inspired by advanced technologies. Each project uses the same common aspects of innovative engineering and technology in an interdisciplinary mindset, in a proper balance with non-engineering aspects such as societal relevance and impact, and ‘out-of-the-box’ business ‘in the niche’ development. The project outcomes are actionable.

The projects are a unique opportunity for cross-disciplinary and holistic work, beyond “engineering bricks“, in which students discover that interdisciplinary problems are often so complicated that it is impossible to know everything one needs to know to fully understand them (Kamp, 2019). These wicked problems are complex in nature, open, interdependent and a moving target (Dorst, 2017). They require an open mindset and interdisciplinary thinking skills to be able to solve these complex problems (Spelt 2017, Boon, 2018, McLeod, 2018).

This Joint Interdisciplinary project welcomes the students as equal participants in problem analysis, problem-solving and knowledge construction. Students are based in the company part of the time and become acquainted with many CEO/Head R&D and other key persons in the company, as well as academic experts. During the course there is a kick-off, focusing on getting the team started on their project work and includes workshops on team building, project management and company content information, such as value-based design, design integration, etc. and 3 major reviews for the assessment of the work. The project work is guided by the company coach, academic staff and the JiP team support staff and is finalised with a public-defence. This course has currently run for the 2nd year with 50 students and 11 companies like Airbus, Royal Haskoning DHV, Huisman, Axxiflex, Arcadis, Feadship, FreshTec, LEAN and WE-P. Next year it is expected to scale up towards 200 students.

As the Joint Interdisciplinary Project is still somewhat in a design prototyping phase we wanted to know with which Interdisciplinary skills master students who are entering the learning environment came in. Do they have an open and interdisciplinary mindset, supposedly necessary for this type of work? We framed this mindset as expectations. Are students aware of these Interdisciplinary skills and do they expect to acquire these skills in JiP? Equally, we wanted to know which of these skills are developed within the JiP course. Spelt (2017), has successfully measured the interdisciplinary mindset of Engineering students in a (Research) University, along the learning dimensions of Iliris (2002). These learning dimensions included a **cognitive learning dimension** (learning to use the content of different disciplines to solve problems), a **social learning dimension** focused on different communications and interactions (e.g. socially engaging with peers and stakeholder to recognise similarities in perceptions and experiences) and **emotional learning dimensions** focusing on well-being and confidence of the students (incentives, challenges, feelings when dealing with interdisciplinary learning).

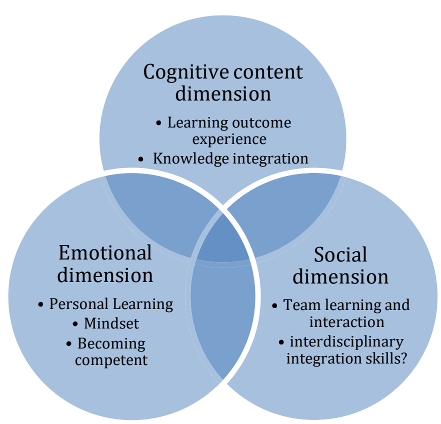

Figure 1. Three learning dimensions and survey structure

Main Research Questions

- What expectations (cognitive, social and emotional) do students have at the beginning of the course? (pre-course survey- students)
- What is the perceived realisation of the learning process in this course? (Post-course survey students)

METHODS: *SURVEY QUESTIONS*

Student pre-survey consisted of 50 questions, measured on a 5 point Likert scale strongly disagree to strongly agree, focused on motivation to participate in JiP and questions about cognitive, emotional and social development. The post-survey consisted of 43 questions, measured on a 5 point Likert scale, one rank-order question and 2 open questions. The questions were partly practical, evaluating elements of the course, and partly repeated questions on the cognitive, emotional and social development. The post-survey specifically explores more practical issues on whether students felt if certain components in the course contributed or hampered their learning. We expect this will strengthen the insight into the course. We rounded off the post-course survey with 3 qualitative questions, what did you lack in the course, three tops and tips of the students for this course and general remarks if there were any.

The Survey questions of the cognitive, emotional and social development in this study have partly been adapted from the three- dimensional model of Spelt et. al. (2018) on Interdisciplinary learning and were calibrated against interview results of Spelt (2018) on these learning dimensions. Survey questions have also been calibrated on Repko(2017) work, who in his work proposes several skills necessary to work in interdisciplinary teams and fitting the cognitive and social dimensions. These are included in a broad model rubric for assessment (p.377) and a service-learning rubric (p.365) to evaluate the interdisciplinary skills of students. The survey consisted of a pre-and post-survey questions amongst students and felt as valid questions to establish the level of expectations and interdisciplinary learning in this course. Similarities and differences are expected to be found between the expectations Pre- survey (zero measurements in week 1) and the experiences post-survey (t 1= week 10 measurement). The hypothesis is that the higher the score on the pre-test, the more an "interdisciplinary mindset" is already present. The lower the score on the pre-test the more steep the learning curve in interdisciplinary learning. In this paper, we will present the findings of the pre-post survey amongst student participants for the cognitive, social and emotional aspects before and after the course.

Method of Data Analysis

Both the pre and post questionnaire reliability was tested with Cronbach’s alpha and were respectively .88 and .86, showing a high overall consistency of the items about what we wanted to measure. The pre-survey response rate was almost 95%, in absolute numbers N= 47 out of 50. The post-survey response rate was 50%, in absolute number 26 out of 50. It means we need to keep into account that the overall numbers are small.

Clustering of the sub-scales on the cognitive- social and emotional aspect was done based on the pre-survey item with a Pearson correlation between different items. Items between 0.30 - .80, which are moderate to fair correlations, were paired into sub-clusters. The post-survey items, when similar to the pre-survey questions were added to the subscales. As the number of respondents was rather small we have not gone beyond reporting descriptive percentages (frequencies)and average means (standard deviations) of the results. Since the overall consistency (Cronbach's alpha) was rather high we feel we can safely continue with descriptive analysis and expect to be giving a fair and relatively representative view of what happened in this course concerning the 3 measured learning dimensions.

RESULTS

This section describes the different components stated in fig.1 of the cognitive content dimension, the social and emotional dimension of learning in an interdisciplinary environment. The similarities and differences are interpreted as expectations prior to the course and having learned something as opposed to not having learned something after the course. In each dimension heading we will repeat the definition of the dimensions, cognitive, social and emotional growth expectations in italics to make reading easier. Each table is a combined description of pre and post-survey results. The pre-test results will be discussed prior to a table, the post test results at the bottom of a table, the conclusion at the end of the dimensions paragraph.

Cognitive Learning Dimension

Cognitive and or content learning dimensions deal with learning how to use the content of different disciplines to solve problems. This also includes activities that provide access to this content.

Learning Outcomes

In table 1 the aggregate findings are presented on the learning outcome component of the cognitive learning dimension. In the pre-test the questions related to the expected learning outcomes are related to being able to apply theoretical concepts to real-life problems (Question 12 pre, Mean 3.8), built a network (Question 36- pre, M=3.8), to revise a viewpoint based on logic and reasoning (Q15 pre, M= 4.1), and gain experience in an innovative professional environment (Q 38- pre - M=4.4.).

Table 1. Learning outcomes experience

	Learning outcomes experience alpha .84 for pre-survey	*Strongly/ disagree*	*Agree nor disagree*	*Strongly/ agree*	*Mean (SD)*
12pre	to understand how to apply theoretical models or concepts to real-life situations	13%	19%	68%	3.8 (.97)
17post	**I have learned to apply theoretical models or concepts to real-life complex problems**	**12%**	**12%**	**76%**	**4.0 (.98)**
36pre	To build a network within my branch of interest	17%	17%	64%	3.8 (1.1)
25post	**I have built a network of contacts within the industry/academia**	**12%**	**24%**	**64%**	**3.6 (1.1)**
38 pre	To gain experience in an innovative professional environment	4%	6%	87%	4.4 (.97)
24 post	**the company gave a lot of opportunities to see its operations**	**40%**	**24%**	**36%**	**3.1 (1.3)**

15	to revise a viewpoint using logic and facts as a basis for reasoning	2%	25%	72%	4.1 (.88)

Results indicate that students perceived their expectations with respect to applying theoretical models to real-life were exceeded and they did learn to do apply theory in practice. Expectations for building a network in academia and industry have been met. Those who did not expect it (the difference between strongly disagree/disagree is 7%) have moved into the area where they might be open to it (agree nor disagree). Concerning gaining experience in a professional environment, it is noted that a lot of students, did not get the opportunity to see the company in operation, or possibly did not have a company visit. Seeing the company in operation strongly depends on the company policies, accessibility and practical limitations of place and distance.

Knowledge Integration

Table 2. Knowledge Integration

Questions nr.	*Knowledge integration pre-survey alpha .77*	*Strongly/ disagree*	*Agree nor disagree*	*Strongly/ agree*	*Mean (SD)*
	I recognize one needs				
14 pre	to zoom in and out of disciplinary focus at different levels of abstraction	2%	15%	81%	4.3 (.82)
19post	**I manage to zoom in and out of disciplinary focus at different levels of abstraction**	**4%**	**12%**	**84%**	**4.2 (.83)**
8pre	to recognise that answers can be based upon various uses of disciplinary knowledge	-	15 %	85%	4.2 (.70)
14post	**To recognise that answers can be based upon various uses of disciplinary knowledge was an eye opener for me**	**16%**	**36%**	**44%**	**3.6 (1.1)**
18 pre	to design an integrated solution to solve the problem defined by the team	4%	4%	90%	4.4. (.79)
32post	**We were able to design an integrated interdisciplinary solution to solve the problem defined by the team**	**4%**	**8 %**	**88%**	**4.4 (.81)**

Table 3 is about knowledge integration and shows the extent to which students were expecting to be able to deal with using disciplinary knowledge to create an integrated design solution. If we look at the pre-test students were rather confident about zooming in at different levels of abstraction Q14 -pre (M =4.3), recognising and using disciplinary knowledge Q8 pre (M = 4.2), and design integration of the solutions Q18 pre (M= 4.4.).

In practice zooming in and out at different levels of abstraction seems to be easily achieved Q19 post (M= 4.2) and it was not a surprise that different uses of disciplinary knowledge could be used Q14 post (M = 3.6). Note that Q14 post? the answer is a negative question, which means that if one strongly disagreed it was not an eye-opener, they were able to recognise easily to use different disciplinary knowledge 16%, 36% unsure and 44% was confronted with an eye-opener at this point. Meaning they had anticipated it but the reality was possibly harder than expected.

Students expectancies with respect to learning content and integrating different types of disciplinary knowledge were largely met in the course. They were specifically disappointed in getting too little information on the company in operation.

Social Learning Dimension

The social learning dimension focuses on communication and interactions with peers and stakeholders, including the skills that are required to realise the interdisciplinary interaction. The dimension is measured by team learning and interaction and interdisciplinary integration skills.

Team learning and interaction

Table 3. Team learning and Interaction

	team learning and interaction - alpha.70	*SD/D*	*DnorA*	*SA/A*	*Mean (SD)*
4pre	To learn from peer perceptions and experiences		4%	93%	4.5(.62)
4post	**I have learned a lot about other disciplines, new topics, experiences from our JiP Team Peers**		**8%**	**92%**	**4.5 (. 65)**
2pre	To recognise similarities in perceptions and experiences, when I engage with peers within the JIP team and context	6%	26%	66%	3.8 (.85)
7post	**I have learned to switch easily between the various viewpoints of others in order to check my own viewpoints**	**4%**	**16%**	**80%**	**4.1 (.81)**
3pre	To be able to engage and share the taken approach, arguments, and decisions within the JIP team and context	2%	4%	92%	4.1 (.85)
8post	**Our team was in it together and shared responsibilities for the team's success or failure**		**8%**	**88%**	**4.8 (.66)**
6pre	To be able to contribute to the learning of the team-partners	2%	15%	81%	4.2 (.80)
5post	**I have been able to contribute to the learning of the team- partners**			**100%**	**4.6 (.51)**

Table 3 particularly dealt with team interaction and peer learning. Results on the pre-course questions show that expectancies about the team interaction and learning thereof either by Q3-pre -sharing perspectives (M= 4.1), Q4 pre-learning from team experiences and peers (M= 4.5), or Q6- pre - contributing themselves to the team learning (M = 4.2) is very high.

In practice (on the post-test) these expectancies were confirmed. Q3 pre was rephrased to Q 8 post sharing responsibilities, the score soared to M = 4.8. Q4 post learning from other disciplines team experience was largely fulfilled score remaining M=4.5 and team contribution Q5- post went up to M= 4.6 and was a 100% positive on team learning!! The students' equally felt they were able to switch between various viewpoints more easily after having finished JiP up from Q2 pre – M= 3.8 to Q7 Post to M = 4.1.

Interdisciplinary integration skills

In table four skills acquiring a helicopter view, switching from viewpoints to benchmark one's viewpoint and justification of decisions based on solid arguments are questioned. Most students expected these skills to be developed Q 9 pre (M= 4.1) , Q11 pre (M = 4.2), Q13/28 pre (both M = 4.1).

Table 4. Interdisciplinary skills integration

	Cognition/ interdisciplinary integration skills - alpha = . 66	*Strongly/ disagree*	*Agree nor disagree*	*Strongly/ agree*	*Mean (SD)*
9pre	To adopt a helicopter view of the interdisciplinary research and the disciplinary contributions	4 %	19%	75%	4.1 (.88)
15post	**I have developed a helicopter view across different fields of knowledge**	**4%**	**4%**	**80%**	**4.0 (.76)**
11pre	To learn to switch easily between the various viewpoints of others in order to check my own viewpoints	4%	17%	76%	4.2 (.90)
7post	**I have learned to switch easily between the various viewpoints of others in order to check my own viewpoints**	**4%**	**16%**	**80%**	**4.1 (.81)**
13pre	to justify decisions made and to compare the issues and arguments raised	4%	11%	85%	4.1 (.73)
28pre	justify decisions made to solve the problems discussed	-	17%	79 %	4.1 (.75)
18post	**I have learned to support arguments to justify decisions made on the topic of study**		**12%**	**88%**	**4.3 (.70)**

In the post-test, this was confirmed and better than expected Q15 post (M= 4.0) with 80% agreeing to strongly agreeing, Q 7 post – (M = 4.1) again with 80% agreeing to strongly agreeing. Q18 post – (M = 4.3) with 88% agreeing to strongly agree. The average not necessarily being higher but more people convinced of their learning or being able to apply this skill. NB that Question 13 and 28 are integrated into the post-test.

On the "social learning dimension," students felt they learned more than expected from other disciplines and were able to contribute to the team learning. They acquired skills such as using a helicopter view, switching from viewpoint and justifications of arguments. This supported their interaction with different disciplines and stakeholders.

Emotional Personal Learning Dimension

The emotional learning focusing on well-being and confidence of the students (incentives, challenges, feelings when dealing with interdisciplinary learning) while interacting with different aspects of interdisciplinary working, such as being on top of the content and social engagement with different peers/stakeholders as well as reflection, critical assessment and self-directedness. The dimension is captured under the heading and tables personal learning, mindset and becoming competent.

Personal learning

Table 5 looks at personal learning increasing personal understanding (q5 pre – M = 4.5), becoming confident (Q26 pre – M = 4.2), noticing a problem has various solutions (Q33 pre – M = 4.4) and making connections more easily across different disciplines (Q 34 pre – M = 4.6).

Table 5. Personal Learning

	personal learning I expect to learn alpha .78	*Strongly/ disagree*	*Agree nor disagree*	*Strongly/ agree*	*Mean (SD)*
5 pre	I expect to increase my personal understanding while reflecting on other disciplinary viewpoints		6%	93%	4.5 (.62)
6post	**I have been able to increase my personal understanding of the world while reflecting on other disciplinary viewpoints**		**16%**	**84%**	**4.2 (.71)**
26 pre	Feeling competent is important		9%	81%	4.2 (1.3)
44post	**I feel more competent and confident after having completed JiP**	**4%**	**16%**	**80%**	**4.1 (1.1)**
33pre	To discuss different solutions scenario's for the topic of study		9%	89%	4.4 (.68)
21 post	**I have come to realise a problem can have many solutions**	**8%**	**8%**	**84%**	**4.2 (.93)**
34pre	To connect more easily with people in different disciplines for the purpose of solving particular problems	2%	4%	92%	4.6 (.71)
16post	**I have learned to connect more easily with people in different disciplines for the purpose of solving particular problems**		**4%**	**88%**	**4.6 (.71)**

The expectations were largely confirmed yet had slightly lower averages and levels of the agreement except for making connections, which was at the same level. Personal understanding (Q6 post – M = 4.2), feeling confident (Q44 post – M = 4.1) , various solutions (Q21post – M = 4.2) and making connections (Q16 post – M = 4.6) . The real world was possibly more complicated than expected and experiencing complexity goes both ways. Being able to deal with complexity gives a boost, but also becoming aware of the vastness of the complexity is a little frightening, showing how little we know to make oneself possibly less confident.

Mindset

Table 6 shows Q24 pre and Q23 post students expected and have acquired new professional skills.

In the majority of the cases, the students were driven to realise personal growth (Q25 pre) and were able to realise this through the personal InterVision and personal reflection that have been part of the course structure. (Questions 28a, 39 post). Fortunately, students felt even more prepared for the industry than expected (Q22 post). The interdisciplinary interrelationships were a little less strongly present than anticipated at the beginning (Q7 pre and 13 Post).

Table 6. Mindset

	mindset alpha = .65	*Strongly/ disagree*	*Agree nor disagree*	*Strongly/ agree*	*Mean (SD)*
24pre	I easily acquire new knowledge	4%	19%	77%	4.0 (.85)
23 post	**I have acquired (new) professional skills**		**12%**	**88%**	**4.3 (.68)**
25pre	I'm seeking personal growth	2 %	2%	92%	4.7 (.70)
28a. 4.post	**The personal intervision supported my personal growth process**	**8%**	**8%**	**80%**	**4.1 (1.0)**
39post	**Personal reflections allowed to monitor my personal development**	**8%**	**20%**	**72%**	**3.9 (.89)**
22 post	**I feel more prepared for a future in industry**	**8%**	**16%**	**76%**	**4.0 (1.0)**
21 pre	I am interested in different topics that contribute to solving societal challenges				4.6 (.69)
7pre	To design conceptual models representing disciplinary interrelationships	8.5 %	28%	61%	3.6 (1.1)
13post	**We have designed conceptual models representing disciplinary interrelationships**	**24%**	**16%**	**56%**	**3.9 (1.3)**

Becoming Competent

Table 7 becoming competent shows that students seem to have a fairly realistic perception of how they address complex problems (Q19 pre-M = 2.7). They didn't expect it to be difficult to use disciplinary knowledge to solve complex problems and Q33 post (M = 3.1) shows that 40% felt it was as difficult as they thought it would be. However, 36% felt it was a rather difficult task as opposed to 15% in the Q19.

Table 7. Becoming Competent

	alpha .56 becoming competent	*SD/D*	*AnorD*	*A/SA*	*Mean (SD)*
19 pre	I find it difficult to match and select disciplinary knowledge to address complex problems	51%	32%	15%	2.7 (1.0)
33post	**The tasks to solve the case were very different from what we imagined and seem very difficult to accomplish**	**40%**	**20%**	**36%**	**3.1 (1.2)**
20pre	I feel uncertain when having to frame a complex problem	45%	30%	23%	2.8 (1.1)
41post	**I feel better able to frame a complex problem after JIP**		**8%**	**84%**	**4.3 (1.1)**
10 pre	To create multiple answers by integrating disciplinary knowledge in various ways	11%	17%	78%	4.1 (1.1)
14post	**To recognise that answers can be based upon various uses of disciplinary knowledge was an eye opener for me**	**16%**	**36%**	**44%**	**3.6 (1.1)**
39pre	To be coached by and learn from professionals		6%	92%	4.6 (.64)
26 post	**The Company coach has given us constructive and relevant feedback**	**4%**	**28%**	**68%**	**4.0 (.88)**
27post	**The Experts (company professionals) have given us constructive and relevant feedback**		**20%**	**80%**	**4.1 (7.3)**
28 post	**The Experts (academic staff) have given us constructive and relevant feedback**	**4 %**	**28%**	**68%**	**4.0 (.89)**

In Q20 pre and Q41 is shown that around 40% feels more confident after Jip framing a complex problem. Learning from professionals 39 pre and Q26/Q27 post it was shown that students expected a lot from the professional (company coach). In the majority of cases, students were still very satisfied, yet it was possibly sobering to experience the professional is only human, like anyone else.

The emotional learning dimension shows that students particularly felt they have acquired new skills, feel better able to frame complex problems and feel more competent to work in the industry after having completed the Joint interdisciplinary Project.

Tops

We finalise with the aspects of learning which are particularly appreciated in the course:

- **Working in an interdisciplinary team:** (with different disciplinary, cultural and educational backgrounds), especially the management site, the inspiration, the great teammates, the different mindsets, becoming more assertive as a person, working 9-5 in a team and learning different skills from team members. (N= 17)
- **Working on a company assignment:** Bringing (your) skills into play on a practical assignment related to our study and contributing to the company product. Getting exposure to working environments in industry and obtaining real insights into how companies and client organisations work in the Netherlands
- **Expanding the Network:** Great networking experience with the reception of valuable feedback with both academic staff, company representatives, professors and professionals from other branches.

DISCUSSIONS & CONCLUSIONS

We have started this paper with the question "What expectations (cognitive, social and emotional) do students have at the beginning of the course?" (pre-survey), "What is the perceived realisation of the learning process in this course? (post-survey students)". Additionally, we had two hypotheses, if there was a high score on the pre-test students might be more interdisciplinary-minded and possibly learned less during the course. If there was a low score they are likely to have learned more.

When studying the results we notice that expectancies at the beginning of the course were rather high on the entire survey. It seems the expectations levels matched what students knew about interdisciplinary learning and the information given before the course has been sufficiently informative. As the post-survey outcomes were equally high we presume that students have been able to apply their interdisciplinary skills in this course or have learned to apply them in this course. The experiences in the "tops- section" confirm that students have learned the interdisciplinary thinking skills set out in the learning dimensions.

We may conclude that an open learning format, where interdisciplinary students teams are in the lead of their learning process, offer a unique opportunity to acquire interdisciplinary thinking skills. Dealing with peers, a variety of different stakeholders in academia and industry allows for a "good" preparation for real-life complex problem-solving. Yet the interaction with industry remains a precarious point as not all companies can provide access to their organisations.
Despite the final remark, it should be noted that expectation management, promising students insight into a company organisation, is a weak point. An alternative way to get a better insight

into the company organisations is to make site visits to an array of companies in a domain of the case studies addressed. It may help to offer engineering students a better perspective on a professional career in Engineering and offer more strategically relevant innovations.

We would like to finish with the general remark of two of our students which nicely summarises the learning curve the students have gone through.

“I found the JIP an enjoyable and very well organized experience. I could only wish that my master program was organized so well. Also, the JIP gave me more insight in how companies work, what their struggles are and how you as a student can still add value even though a company may be very well established with thousands of employees and years of successful operation”

“A great experience with amazing people!”

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BIOGRAPHICAL INFORMATION

Renate G. Klaassen, Dr. is a programme coordinator and researcher, working at the 4 TU Centre for Engineering Education at TU Delft. Areas of research interest pertain to content, language integrated learning in higher education, interdisciplinary learning, engineering roles for the Future of Higher Engineering Education and conceptual understanding in engineering education. In the recent past, she has been heavily involved in educational advising on the innovation of the BSc in Aerospace Engineering, and various other curriculum reforms at TU Delft. Consultancy activities include assessment (policy, quality and professionalization), internationalisation of university education and design education.

Birgit de Bruin is Managing strategic interdisciplinary engineering & educational projects, enhancing strategic liaisons between education and business and has been one of the initiators of the Joint Interdisciplinary Project. Other projects involve Business (context) development, interdisciplinary strategic projects for education, curriculum development, liaisons management, bridging the gap between young talent and their future professional environment in engineering.

Nanneke de Fouw is currently a senior researcher for 4TU-CEE at TU Delft. She holds a PhD in Medical Biology (University of Utrecht). She has more than 25 years' experience in leading and facilitating multidisciplinary teams at major multinational FMCG companies, in product innovation and learning. She holds certifications in Belbin, MBTI and Prince 2, and is a certified IAF facilitator. Her interests are in the development of young professionals in their interdisciplinary environment.

Aldert Kamp the Director of Education for the Faculty of Aerospace Engineering at TU Delft, the Netherlands since 2007. He is deeply involved in the rethinking of engineering education at the university level with a horizon of 2030, as a response to the rapidly changing world. More than 20 years of industrial experience in space systems engineering and 10 years of academic experience have given him the insight into the capabilities tomorrow's engineers need in the future world of work. Aldert has been involved in university-level education policy development, renovations of engineering curricula and audits of Dutch and international academic programmes. He is Global Leader of CDIO Initiative, the global innovative education framework for producing the next generation of engineers, and is TU Delft Leader of the Dutch 4TU Centre of Engineering Education (4TU.CEE) that facilitates innovations in higher engineering educational programmes within and outside the Netherlands.

Hans Hellendoorn is Director of Education and of the graduate school at the faculty of Mechanical, Maritime and Materials Engineering. The faculty counts over 4.700 student and 300 PhD. More than 20 years of industrial R&D and innovation experience gave him insight into the relevance of industrial involvement in the master education for future engineers. In 2018 he became Chair of the Cognitive Robotics Department
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