Basic need frustration in motivational redesign of engineering courses

BASIC NEED FRUSTRATION IN MOTIVATIONAL REDESIGN OF ENGINEERING COURSES

Gunter Bombaerts

Eindhoven University of Technology, the Netherlands

ABSTRACT

Engineering Education aims at realizing students' satisfaction and intrinsic motivation. However, students' frustration is never fully banned. In this article, I argue that one of the reasons for the limited focus on frustration in Engineering Education is the limited focus on frustration in classical motivational theory itself. I focus on Self-Determination Theory and distinguish between the early work focussing on satisfaction and the recent work considering frustration as a distinct active threat. I will complement this theoretical approach with an empirical analysis of data from a large ethics of technology course in 2016 and 2020 at Eindhoven University of Technology. Two research questions are asked: "(RQ1) Do basic needs satisfactions and frustrations in the USE basic course confirm the asymmetrical pattern described in recent literature?"; and "(RQ2) Do basic needs frustrations add to the variance of motivation types?" I performed principal axis factoring with an oblique rotation to answer RQ1 and stepwise regression analyses to answer RQ2. I conclude that basic need frustration can be measured as a clearly different concept compared to satisfaction and that splitting these two concepts is helpful for Engineering Education when studying motivation. I discuss two main avenues for Engineering Education: motivational theories should take need profiles and need trajectories into account in course design; and motivational research should inquire how individuals can learn to cope adaptively with need-frustrating experiences.

KEYWORDS

Self-Determination Theory, frustration, basic need, motivation, engineering ethics, Standards: 3, 4, 7.

INTRODUCTION

Engineering Education aims at realizing students' satisfaction and intrinsic motivation to increase students' engagement and deeper learning (Bombaerts et al., 2019; Doulougeri & Bombaerts, 2019). However, students' frustration is never fully banned; often leading to frustration of course designers and teachers. In this article, I argue that one of the reasons for the limited focus on frustration in Engineering Education is the limited focus on frustration in classical motivational theory itself.

I take Self-Determination Theory (SDT) (Ryan & Deci, 2000) as example as it is currently a prominent motivational theory in Engineering Education (Gunter Bombaerts & Spahn, 2019). SDT provides concrete pedagogical advice by increasing students' three psychological basic need, "psychological nutrients that are essential for individuals' adjustment, integrity, and growth" (Ryan, 1995; Vansteenkiste et al., 2020). Providing meaningful choices - not "whatever students want to choose" – increases students' *autonomy*. A warm connection with peers and teachers will create *relatedness*. And a task that is challenging enough but not too difficult will increase students' feeling of *competence*. SDT states that these basic needs influence different types of motivation. They increase *autonomous motivation* (motivation that is intrinsic or sufficiently internalised) and *controlled motivation* (motivation because of internal or external pressures) and decrease *amotivation* (no motivation, avoiding the task and caring about not doing it).

The early focus of basic psychological needs theory (BPNT) was on the satisfaction of the three basic psychological needs (Ryan, 1995). Research from Bartholomew et al. (2011) and Vansteenkiste and Ryan (2013) shed light to what they call the "dark side of human functioning" and basic needs frustrations. They showed that both satisfaction and frustration of basic psychological needs have an asymmetrical relation, as the absence of the one does not automatically mean the presence of the other. As such, they are both active threats and distinct concepts (Vansteenkiste et al., 2020). This empirically means that they appear as different factors and are negatively correlated. Basic need frustration also adds to the prediction of more negative aspects as ill-being. It indicates frustration entails extra functional costs like disengagement, distress (Bartholomew et al., 2011; Jang et al., 2016) and amotivation (Haerens et al., 2015).

In this article, I sketch some elements of this theoretical debate and link it to Engineering Education. I will complement this with an empirical analysis of data from a large ethics of technology course in 2016 and 2020 at Eindhoven University of Technology. I conclude that basic need frustration can be measured as a clearly different concept compared to satisfaction and that splitting these two concepts is helpful for Engineering Education when studying motivation.

CONTEXT

I briefly sketch here the course in which data are collected. I stress that this article has not the ambition to conclude course redesign recommendations based on the theoretical and empirical research. It is merely used as a contextualisation of how students' need frustration can be measured in Engineering Education.

The context of this study is a basic course of ethics and history of technology. This basic course is a complex course, part of a set of four non-technical courses (Bekkers & Bombaerts, 2017) in the Bachelor's study program focusing on "User, Society and Enterprise (USE)" aspect of technology. This ‘USE basic course’ is an eleven-week required course and takes place in the fourth quartile of the first year. In 2016 it consisted of a group of 1864 students at the start, from 15 different engineering training programs, offered in two languages (native Dutch and English) by two groups of teachers (the history and the ethics group). The students were divided in 8 groups of about 250 students for lectures on two different days of each course week, and in 32 groups of about 60 students for weekly tutorials. Students had one assignment in which they applied theories to an existing socio-technical problem. History and Ethics lectures were alternated to give input in a combined group assignment on Ethics and History of technology. The assignment weighed for 40% of the final grade, the theoretical final exam for an additional 50%. Finally, students could practice for the final exam with the help of 3 online quizzes. The two best quizzes counted for the remaining 10% of the final grade. The 2020 had several changes, but the overall large-scale complexity remained.

RESEARCH QUESTIONS

Based on the recent literature and this case, I come to the two following search questions: “(RQ1) Do basic needs satisfactions and frustrations in the USE basic course confirm the assymetrical pattern described in recent literature?”; and “(RQ2) Do basic needs frustrations add to the variance of motivation types?”

ANALYSIS

Procedure, Sample and Instruments

Students received an invitation by email to fill out an electronic questionnaire, asking for informed consent and no compensation was given. Researchers only could work with the anonymized master file, in agreement with the national law and the data protection officer.
The response rate was sufficient (Nulty, 2008) with 37.4% (631 out of 1702 students that handed in their end exam in the first exam period) in 2016 and 26.5% (439 out of 1654 students) in 2020.

Student *autonomous motivation* and *amotivation* was measured in 2016 and 2020 and *controlled motivation* was only measured in 2016, using the ‘Self-regulation questionnaire–Academics’ (SRQ-A) (SDT, 2014; Vansteenkiste et al., 2005). To measure basic needs in 2016, the *Basic Psychological Need Satisfaction Scale – Work Domain* (see BPNW “Basic Psychological Needs at Work,” n.d. for items) was used measuring the three basic need satisfaction factors with 3 positively and 3 negatively formulated items. Reference to the USE basic course was added to the items. In 2020 the Basic Psychological Need Satisfaction and Frustration Scale (see BPNSFS; Chen et al., 2015, 227 for items) was used. It measures three basic needs satisfaction factors and three basic need frustration factors with four items per factor.

Factor Analysis

The motivational items in 2016 have been analyzed with principal axis factoring with an oblique rotation based on eigenvalues. Most items loaded on factors as expected with two main exceptions. One item of the *extrinsic* factor (“*I am motivated to study for the USE basic course because I’m supposed to do so.*”) consistently did not load on any factor, therefore, this item was removed from further analyses. All items from *autonomous motivation* and *amotivation* loaded on their factor. The items from controlled motivation loaded on two factors, known in SDT as *introjected* and *extrinsic* regulation. The four-factor analysis accounted for between 69% of the variance. For 2020, two factors *autonomous motivation* and *amotivation* also appeared in a principal axis factoring with an oblique rotation with 65% variance explained. Cronbach Alpha reliabilities all ranged between .75 and .92.

To answer the first research question RQ1, also for the basic needs items, principal axis factoring with an oblique rotation has been performed based on eigenvalues and set the expected number of factors based on theory on two factors (in which I expect to find a division between satisfaction and frustration items) and six factors (where I expect to find the three satisfaction and three frustration items). I use notations as “Aut+” as the factor containing the positively formulated items of autonomy satisfaction and “Rel-“ the negatively formulated items of relatedness satisfaction. For the 2016 data, our analysis based on eigenvalues showed (See Table 1 loadings) 4 factors explaining 45.3% of the variance, roughly Aut+/Comp+, Rel+/Rel-, Aut- en Com-. Here “Aut+” refers to the factor of autonomy satisfaction and “Rel-“ to relatedness frustration. The two-factor analysis very clearly shows the split of positively and negatively formulated items with 40.0% explained variance. All 18 items loaded less between -.155 and 0 on the other factor, except for *Rel2-* “There are not many fellow students or tutors in my course that I was close to.”, which loaded for -.249 on the other factor. The six factor gives Aut+/Rel+, Comp+, Aut-, Rel-, Comp- and 1 rest-factor collecting 2 competence items with 49.8% variance explained.

Table 1: 2016 data pattern matrix, principal axis factoring with an oblique rotation based on eigenvalues and two and six factors, factor loading < .4 not presented. Aut+ and aut- refer to the BPNW scales with the positively and negatively formulated autonomy satisfaction items; same for Rel+, Rel-, Comp+ and Comp-.

	Eigenvalues				**2 factors**		**6 factors**					
Factor→ ↓Items	1	2	3	4	1	2	1	2	3	4	5	6
Aut+1			.595		.622		.469					
Aut+2		-.418	.461		.690		.728					
Aut+3					.624		.751					
Rel+1			.414	-.653	.704		.588			-.418		
Rel+2				-.630	.716		.705					
Rel+3	.510				.697		.717					
Comp+1			.588		.509							.829
Comp+2			.831		.565				.837			
Comp+3			.824		.569				.828			
Aut-1	.648					.593		.798				
Aut-2	.678					.526		.834				
Aut-3	.439	.483				.671		.524				
Rel-1				.620		.539				.676		
Rel-2				.770		.479				.769		
Rel-3		.543		.450		.623					.411	
Com-1		.776				.654					.856	
Com-2	.451					.612			-.460			.405
Com-3		.822				.698					.800	

For the 2020 data, the eigenvalues factor analysis showed (see Table 2) four factors explaining 49.8% of the variance, roughly Aut+/Aut-, Aut- en Comp+/Comp-, Rel+ and Rel-. The two-factor analysis again, although in a less clear way, shows the split of satisfaction and frustration items with 35.9% explained variance. The six factor gives Aut+, Rel+, Comp+/Comp-, Aut-, Rel- and one rest factor and explains 53.9% of the variance. Cronbach alpha's for all these factors were between .70 and .85 (after deletion of 1 factor in Rel- "I feel the relationships I have in this course are just superficial.").

Table 2: 2020 data pattern matrix, principal axis factoring with oblique rotation based on eigenvalues and two and six factors, factor loading < .4 not presented. Aut+ and aut- refer to the autonomy satisfaction and frustration in BPNSFS; same for Rel+, Rel-, Comp+ and Comp-.

	Eigenvalues				*2 factors*		*6 factors*					
Factor→ ↓Items	1	2	3	4	1	2	1	2	3	4	5	6
Aut+1		.492				.498						.406
Aut+2		.438				.619		.789				
Aut+3		.420				.680		.743				
Aut+4		.611				.629						
Rel+1				-.666		.557				-.606		
Rel+2				-.690		.559				-.682		
Rel+3				-.872		.599				-.863		
Rel+4				-.644		.535				-.618		
Comp+1	-.779				-.581		-.797					
Comp+2	-.798				-.641		-.748					
Comp+3	-.737				-.518		-.754					
Comp+4	-.708				-.506		.565					
Aut-1		-.761				-.420			.773			
Aut-2		-.714							.706			
Aut-3			.428		.422							
Aut-4		-.771				-.446			.794			
Rel-1			.485		.458						.598	
Rel-2			.589		.502						.586	
Rel-3			.602		.602						.677	
Rel-4							-.766					
Comp-1	.601				.793		.402					
Comp-2	.419				.683						.581	
Comp-3	.434		.555		.810		.479					
Comp-4	.514		.406		.772							.406

Table 3 provides correlations for the basic need scales for 2016 and 2020, respectively above and below the diagonal.

Model prediction

To answer the second research question RQ2, multiple stepwise regression analyses were performed, with basic needs variables as predictors, and motivation as dependent variable, to find out whether the inclusion of the basic needs frustration variables would increase the explained variance of motivation. In the first step of the analyses, only basic needs satisfaction variables were entered (Model 1 in Table 4), and in the second step, the basic need frustration variables were added (Model 2). Difference in explained variance (R^2) was calculated. The results of these analyses are shown in Table 4.

Table 3: Basic needs scale correlations. For 2016 (above diagonal), aut+ and aut- refer to the BPNW scales with the positively and negatively formulated satisfaction items; for 2020 (below diagonal), aut+ and aut- refers to satisfaction and frustration in BPNSFS.

Factor	*1.*	*2.*	*3.*	*4.*	*5.*	*6.*
1. Aut+	-	.58**	.45**	-.07	-.16**	-.21**
2. Rel+	.42**	-	.35**	.01	-.41**	-.17**
3. Comp+	.33**	.22**	-	-.10*	.01	-.08*
4. Aut-	-.50**	-.21**	-.24**	-	.31**	.40**
5. Rel-	-.03	-.19**	-.29**	.35**	-	.44**
6. Comp-	-.07	-.052	-.63**	.35**	.58**	-

Table 4: Summarized Results for Stepwise Regression Analysis for Predicting Motivation Variables with Basic Needs Variables. Model 1 = Aut+, Rel+, Comp+. Model 2 = Aut+, Rel+, Comp+, Aut-, Rel-, Comp-.

		Model 1		**Model 2**		
Dependent	**Year**	**R^2**	**F**	**R^2**	**F**	**ΔR^2**
Autonomous	2016	.39	115.12*	.39	186.7*	.00
Introjected		.13	29.89*	.18	23.49*	.06
Extrinsic		.06	13.93*	.22	29.30*	.16*
Amotivation		.11	25.13*	.28	40.21*	.17*
Autonomous	2020	.52	470 .3*	.56	181.6*	.04
Amotivation		.20	55.9*	.35	76.1*	.15*

*Note: * $p < 0.001$*

The results show that the addition of basic needs frustration variables gave a significant increase in predictive power for *extrinsic regulation* and *amotivation*. The inclusion of these variables seems important, as the explained variances show a strong increase from Model 1 to Model 2.

DISCUSSION AND CONCLUSION

In order to give meaning to the two clearly separated factors in the two factor analysis in the BPNW in 2016, we elsewhere propose to interpret them as 'satisfaction' and 'frustration' (Gunter Bombaerts & Spahn, 2019), of course knowing that this instrument is not validated to measure basic need satisfaction and frustration. Nevertheless, items as "I felt pressured to do things in a certain way during the course." (*Aut1-*) show a clear frustration aspect. Doing this, both the 2016 and 2020 clearly differentiated factors. As such, I can confirm the first research question that basic needs satisfactions and frustrations in the USE basic course confirm the asymmetrical pattern described in recent literature. I should note, however, that the BPNW that is not designed to measure frustration gives a more pronounced separation than the BPNSFS that is specifically designed to measure it. Secondly, the analysis also confirmed that basic needs frustrations add to the variance of more negatively oriented motivation types as *extrinsic regulation* and *amotivation*. This means that for researchers who are interested in *controlled motivation* (*introjected* and *extrinsic regulation*), or *amotivation*, the basic need frustration variables should be included in their analyses, as separate variables.

I am aware this article has many limitations. First of all, the article is very exploratory. I do not use qualitative data to further understand *how* USE basic students experience their frustration, how students differ or show similarities, or how frustration changes. Furthermore, this article only uses two instruments of one motivation theory. As such, the article does not make a statement on motivation and frustration in general. A third limitation is the elaboration of existing literature of compensatory behaviour outside SDT. The only excuse I can bring in for these limitations is the paper length limitation, since they are all very important and need to be further elaborated.

The current literature studies how students confronted with basic needs frustration try to actively compensate for frustrated needs, such as developing rigid behaviour patterns, developing contingent self-worth, oppositional defiance, the pursuit of need substitutes or need sacrificing (Vansteenkiste et al., 2020). This is what teachers experienced in the ethics and history of technology course. Students asked to do an ethical analysis of existing socio-technical problem might experience difficulties with the openness of the assignment (Bombaerts et al., 2018; Bombaerts & Martin, 2019). They may compulsively hold on to specific routines that operate as scripts for the behaviour they imagine they need to do. Some students for example stick to technical engineering methods to solve a problem instead of using more social science methods in the hope they find temporal forseeableness, security or stability (Deci & Ryan, 2000). Students can develop contingent self-worth (Kernis, 2003). Resistance to engage in a non-technical course and in-group expressions of "use is useless" can be interpreted as signs of active compensation attempts to find a balance between the current, often more technical, view on engineering and the alternative views proposed in an ethics of technology course. This can lead even to oppositional defiance if this when students more publicly raise these concerns and try to use tutorials to find group support to escape from an experience of control (Koestner & Losier, 1996). A far less extreme and almost general reaction to basic need frustration is the shift from an intention for deep learning to surface learning (Marton & Säaljö, 1976) as a pursuit of need substitutes and need sacrificing (Holding et al., 2020).

Vansteenkiste et al. (2020) give several future directions for basic psychological need theory. Two avenues are of particular importance for this study. Firstly, as Vansteenkiste and Mouratidis (2016) illustrate, SDT should take need profiles and need trajectories into account. Course redesign will increase with better insights in clusters of students sharing a same basic psychological need, both satisfaction and frustration, when confronted with specific requirements from an engineering education course (Warburton et al., 2020). Gillet et al. (2019)

showed considerable heterogeneity in need trajectories, illustrating the importance to be well aware how students might experience frustration during the course. A second avenue relevant for this study is that motivational research should inquire how individuals can learn to cope adaptively with need-frustrating experiences. Frustration in itself is not a bad thing. It can be a positive sign of a technical worldview being confronted with more complex socio-technical challenges. Waterschoot et al. (2020) for example showed the role of feedback to coping strategies using competence-relevant cues. Good feedback in Engineering Education (Bombaerts & Nickel, 2017; van Diggelen et al., 2019) can also shift students frustration and resilience to motivation and engagement.

This opens a broad range of further questions for research and education beyond the scope of this article. Is there a difference between good, constructive and bad, destructive frustration? Should education steer toward constructive frustration for better learning or should it avoid this and only aim for satisfaction and intrinsic motivation? How to recognise and constructively use good frustration in engineering education?

REFERENCES

Bartholomew, K. J., Ntoumanis, N., Ryan, R. M., Bosch, J. A., & Thøgersen-Ntoumani, C. (2011). Self-determination theory and diminished functioning: The role of interpersonal control and psychological need thwarting. *Personality and Social Psychology Bulletin*, *37*(11), 1459–1473.

Basic Psychological Needs at Work. (n.d.). Retrieved March 30, 2018, from http://selfdeterminationtheory.org/basic-psychological-needs-scale/

Bekkers, R., & Bombaerts, G. (2017). Introducing Broad Skills in Higher Engineering Education: The Patents and Standards Courses at Eindhoven University of Technology. *Technology & Innovation*, *19*(2), 493–507. https://doi.org/10.21300/19.2.2017.493

Bombaerts, G., Doulougeri, K. I., & Nieveen, N. M. (2019). Quality of ethics education in engineering programs using Goodlad's curriculum typology. *Proceedings of the SEFI 47th Annual Conference*, 1424–1436.

Bombaerts, G. J. T., Doulougeri, K. I., Spahn, A., Nieveen, N. M., Pepin, B. E. U., Clark, R., Munkebo Hussmann, P., Järvinen, H.-M., Murphy, M., & Etchells Vigild, M. (2018). The course structure dilemma: Striving for Engineering students' motivation and deep learning in an ethics and history course. *46th SEFI Annual Conference 2018: Creativity, Innovation and Entrepreneurship for Engineering Education Excellence*, 79–87.

Bombaerts, G., & Martin, D. A. (2019). Case Studies in Engineering Ethics Education. *Proceedings of the SEFI 47th Annual Conference*, 2039–2041.

Bombaerts, G., & Nickel, P. J. (2017). Feedback for relatedness and competence: Can feedback in blended learning contribute to optimal rigor, basic needs, and motivation? *2017 IEEE Global Engineering Education Conference (EDUCON)*, 1089–1092. https://doi.org/10.1109/EDUCON.2017.7942984

Bombaerts, Gunter, & Spahn, A. (2019). Simplify! Using self-determination theory to prioritise the redesign of an ethics and history of technology course. *European Journal of Engineering Education*, 1–17. https://doi.org/10.1080/03043797.2019.1702924

Chen, B., Vansteenkiste, M., Beyers, W., Boone, L., Deci, E. L., Van der Kaap-Deeder, J., Duriez, B., Lens, W., Matos, L., Mouratidis, A., Ryan, R. M., Sheldon, K. M., Soenens, B., Van Petegem, S., & Verstuyf, J. (2015). Basic psychological need satisfaction, need frustration, and need strength across four cultures. *Motivation and Emotion*, *39*(2), 216–236. https://doi.org/10.1007/s11031-014-9450-1

Doulougeri, K. I., & Bombaerts, G. (2019). *The influence of learning context on engineering students' perceivedbasic needs and motivation.* 2019 ASEE Annual Conference & Exposition, Tampa, United States.

Gillet, N., Morin, A. J. S., Huyghebaert, T., Burger, L., Maillot, A., Poulin, A., & Tricard, E. (2019). University students' need satisfaction trajectories: A growth mixture analysis. *Learning and Instruction*, *60*, 275–285. https://doi.org/10.1016/j.learninstruc.2017.11.003

Haerens, L., Aelterman, N., Vansteenkiste, M., Soenens, B., & Van Petegem, S. (2015). Do perceived autonomy-supportive and controlling teaching relate to physical education students' motivational experiences through unique pathways? Distinguishing between the bright and dark side of motivation. *Psychology of Sport and Exercise*, *16*, 26–36.

Holding, A. C., St-Jacques, A., Verner-Filion, J., Kachanoff, F., & Koestner, R. (2020). Sacrifice—but at what price? A longitudinal study of young adults' sacrifice of basic psychological needs in pursuit of career goals. *Motivation and Emotion*, *44*(1), 99–115.

Ilardi, B. C., Leone, D., Kasser, T., & Ryan, R. M. (1993). Employee and supervisor ratings of motivation: Main effects and discrepancies associated with job satisfaction and adjustment in a factory setting. *Journal of Applied Social Psychology*, *23*(21), 1789–1805.

Jang, H., Kim, E. J., & Reeve, J. (2016). Why students become more engaged or more disengaged during the semester: A self-determination theory dual-process model. *Learning and Instruction*, *43*, 27–38.

Kernis, M. H. (2003). Toward a conceptualization of optimal self-esteem. *Psychological Inquiry*, *14*(1), 1–26.

Koestner, R., & Losier, G. F. (1996). Distinguishing reactive versus reflective autonomy. *Journal of Personality*, *64*(2), 465–494.

Marton, F., & Säaljö, R. (1976). On qualitative differences in learning—Ii Outcome as a function of the learner's conception of the task. *British Journal of Educational Psychology*, *46*(2), 115–127.

Nulty, D. D. (2008). The adequacy of response rates to online and paper surveys: What can be done? *Assessment & Evaluation in Higher Education*, *33*(3), 301–314.

Ryan, R. M. (1995). Psychological needs and the facilitation of integrative processes. *Journal of Personality*, *63*(3), 397–427.

Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology*, *25*(1), 54–67.

SDT. (2014). *Academic self-regulation questionnaire (SRQ-A) [Forum] Retrieved from: Http://selfdeterminationtheory.org/download/srq-academic/?wpdmdl=3621.*

van Diggelen, M. R., Doulougeri, K. I., Gomez-Puente, S. M., Bombaerts, G., Dirkx, K. J. H., & Kamp, R. J. A. (2019). Coaching in design-based learning: A grounded theory approach to create a theoretical model and practical propositions. *International Journal of Technology and Design Education*. https://doi.org/10.1007/s10798-019-09549-x

Vansteenkiste, M., & Ryan, R. M. (2013). On psychological growth and vulnerability: Basic psychological need satisfaction and need frustration as a unifying principle. *Journal of Psychotherapy Integration*, *23*(3), 263.

Vansteenkiste, M., Ryan, R. M., & Soenens, B. (2020). *Basic psychological need theory: Advancements, critical themes, and future directions*. Springer.

Vansteenkiste, M., Zhou, M., Lens, W., & Soenens, B. (2005). Experiences of autonomy and control among Chinese learners: Vitalizing or immobilizing? *Journal of Educational Psychology*, *97*(3), 468.

Warburton, V. E., Wang, J. C., Bartholomew, K. J., Tuff, R. L., & Bishop, K. C. (2020). Need satisfaction and need frustration as distinct and potentially co-occurring constructs: Need profiles examined in physical education and sport. *Motivation and Emotion*, *44*(1), 54–66.

Waterschoot, J., van der Kaap-Deeder, J., & Vansteenkiste, M. (2020). The role of competence-related attentional bias and resilience in restoring thwarted feelings of competence. *Motivation and Emotion*, *44*(1), 82–98.

BIOGRAPHICAL INFORMATION

Gunter Bombaerts is Assistant Professor in Ethics of Technology, Faculty of IE&IS, TU Eindhoven, the Netherlands. He is coordinator of the User-Society-Enterprise program at TU/e. His expertise covers energy ethics, system philosophy and engineering ethics education. Gunter is involved in the SEFI Ethics Special Interest Group.

Corresponding author

Gunter Bombaerts
Eindhoven University of Technology (TU/e)
Dept IE&IS, group Philosophy&Technology
Building Atlas, Room 9.326
Groene Loper 3
5612 AE Eindhoven
g.bombaerts@tue.nl