2023

The Power Of Perspective Dialogue: Unlocking Transformative Reflection In Engineering Education (Practice)

Pleun HERMSEN
Delft University of technology, Netherlands, The, p.e.a.hermsen@tudelft.nl

Sjoerd VAN DOMMELEN
Delft University of technology, Netherlands, The, s.vandommelen@tudelft.nl

Paula HUESO ESPINOSA
Delft University of technology, Netherlands, The, p.huesoespinosa@tudelft.nl

See next page for additional authors

Recommended Citation

Hermsen, P., van Dommelen, S., Hueso Espinosa, P., & van den Bogaard, M. (2023). The Power Of Perspective Dialogue: Unlocking Transformative Reflection In Engineering Education (Practice). European Society for Engineering Education (SEFI). DOI: 10.21427/ED54-6E19

THE POWER OF PERSPECTIVE DIALOGUE: UNLOCKING TRANSFORMATIVE REFLECTION IN ENGINEERING EDUCATION (PRACTICE)

P.E.A. Hermsen[1]
TU Delft
Delft, the Netherlands
ORCID 0009-0006-7747-1865

S. van Dommelen
TU Delft
Delft, the Netherlands
ORCID 0009-0003-7388-7255

P. Hueso Espinosa
TU Delft
Delft, the Netherlands
ORCID 0009-0009-2342-3333

M.E.D. van den Bogaard
University of Texas at El Paso
El Paso TX, USA
ORCID 0000-0002-2267-3674

Conference Key Areas*: Innovative Teaching and Learning Methods, Engineering Skills*
Keywords*: Reflection, Transformative Reflection, Education Innovation*

ABSTRACT

Engineers need to be socially responsible, ethically aware and deliver positive contributions to the wicked problems[2] of today's global challenges. In navigating these challenges, being able to reflect is a necessary prerequisite. But if we simply ask students reflective questions, they tend to give us mostly socially desirable answers. Our university initiated an institute-wide program focused on creating learning experiences and environments for transformative reflection instead of superficial reflection. In this paper we present design principles for transformative reflection based on a literature overview and the program's accumulated experience. The principles are I) Six domains for reflection on engineering issues, II) The differentiation between the internal and external perspectives, III) Our approach to

[1] *Corresponding Author: P.E.A.Hermsen@tudelft.nl*
[2] The term 'wicked problem' refers to that class of social system problems which are ill-formulated, where the information is confusing, where there are many clients and decision makers with conflicting values, and where the ramifications in the whole system are thoroughly confusing (Churchman, 1967).

design for context-specificity of transformative reflective experiences, and IV) Four mechanisms that foster transformative reflection.

---

1 INTRODUCTION

Our complex, fast-changing world is intertwined with technology (Australian Council of Engineering Deans 2021) and our planet and humankind are facing many challenges, including climate change, pollution, social injustice, energy transition, affordable healthcare, etc. (Gürdür Broo, Kaynak, and Sait, 2022). Engineers are part of the multidisciplinary teams that will address such challenges. However, successful team members require a skillset that has not been strongly considered in engineering education (Hirsch and McKenna 2008; Gürdür Broo, Kaynak, and Sait 2022; Schuelke-Leech 2020). Transversal skills deemed important for teamwork such as communication found their way into engineering curricula, yet skills such as reflection, resilience, or the ability to reassess choices if a situation changes, awareness of ethics, social injustice, bias, and unintended implications of engineering practice have not.

Schön introduced the concept of reflection in the broader academic discourse with his seminal book on reflective practitioners in 1983 and the concept has been "widely and diversely used" (Kember et al. 2008, p 369). Reflection is directly related to self-awareness, to improving learning outcomes, to developing professionally and to understanding others (Chan & Lee, 2021). Mello and Wattret (2021) postulate that reflection is a conditional skill that enables students to develop other transversal skills, such as resilience and communication skills. The call to embed reflection in engineering curricula has been explicitly stated by authors such as Turns et al. (2014), and Chan and Lee (2021), or implicitly assumed by other sources such as the MIT mission statement that includes reflection as an implicit prerequisite for solving the global challenges (MIT, 2022) and the TU Delft criteria for Bachelor programs (Meijers et al, 2005). In this paper we present the first steps in creating an institution-wide program to develop integrations for reflection in the curriculum. We present a literature overview on barriers to implementing reflection, which we complement with our own experiences and reflections, and we present instructional design principles for transformative reflection.

2 REFLECTION IN ENGINEERING EDUCATION: EASIER SAID THAN DONE

There are many reasons why embedding reflection in engineering curricula is challenging. In this section we present a literature overview (Grant and Booth, 2009) on why it is challenging and what barriers get in the way. We complement the literature overview with outcomes of participatory research with engineering educators in our institution in 2021 and 2022 (Hermsen et al, 2022).

Reflection can mean many different things in many different contexts, and different fields of application have different definitions (Chan, Wong, and Luo 2021; Akbari 2007; Cotton 2001; Tsingos, Bosnic-Anticevich, and Smith 2014; LaBoskey 1994). Reflection involves carefully evaluating and making sense of one's behavior, beliefs, and perspectives , which can lead to both useful insights and uncomfortable realizations of weaknesses or mistakes (Chan, Wong, and Luo 2021; Mezirow 1998; Boud, Keogh, and Walker 1985; Grant, Franklin, and Langford 2002). Facing personal aspects can be experienced as difficult and even threatening, causing self-

doubt and non-constructive self judgments (Hobbs 2007; Bharuthram 2018). Lönngren (2017) stated that reflection is often considered to be in tension with the technology-oriented culture of engineering sciences, which prioritizes measurable outcomes and linear problem-solving (see also Schuelke-Leech, 2020). This conflict is caused because reflection involves abstract connections and perspective-taking, and is often associated with dealing with emotions and vulnerability. As a result, many engineers perceive time spent on reflection as time lost on disciplinary knowledge (Hobbs 2007; Chan, Wong, and Luo 2021; Bharuthram 2018). This prospect may make instructors reluctant to reflect or incorporate reflection into their teaching and have students engage with it.

Meaningful reflection does not happen by itself: Meijers and Mittendorf (2017) found that, in spite of teachers' attention to reflection in assignments, students often provide socially desirable responses and struggle to find meaning in reflective exercises if they receive little instruction or guidance. In technical subjects it is important to scaffold, and the same goes for learning to reflect, as reflection without instruction and practice results in superficial reflections that have a minor impact on learning at best (McIntosh 2010; Ryan 2013). Instructors and students find it challenging to integrate reflection in daily practice and provide meaningful guidance through the process (McIntosh 2010; Ryan 2013). Students experience reflection-fatigue when they are asked to reflect on a regular basis (Kinkhorst 2010) or even turn into ‘reflective zombies’, which happens when reflection becomes superficial, repetitive, unproductive or even counterproductive (De la Croix and Veen 2018; Bharuthram 2018).

Although there is a considerable body of knowledge on the topic of reflection, authors often fail to describe how their design and application of reflection have been tailored to a specific context. This makes it hard for instructors to understand how to take contextual factors into account in their own courses. Some publications on reflection are highly theoretical and strongly rooted in philosophy, while other publications are very practical, yet often do not apply to the instructor’s context. Assignments for meaningful reflection need to hit a sweet spot, as assignments need to have a certain level of practicality for students to be able to relate to it, yet by making it too practical it can easily end up becoming a tick-box activity, where the recording of compliance with assessment requirements is more prevalent than actual learning (Barak 2006; Platt 2014).

There are practical barriers to implementation of reflection in coursework. Searches for articles on reflection in (engineering) education tend to yield many hits that include publications on education as well as the subject of reflection, which makes it overwhelming for laypersons to find appropriate resources. From an instructional design perspective, there are many supporting or limiting factors for (classroom) assignments: how big is the group, what year are students in, how familiar are these students with reflection, what kind of learning activity is it part of? Is the physical space safe and inviting, are there any language barriers present, when should reflection be scheduled, and will there be opportunities to provide feedback and debriefing to the reflection exercises? Due to all these challenges instructors may lack confidence or feel resentful about delivering guidance for reflection, as it adds to their workload or ‘distracts’ them from research practice (Beard, Clegg, and Smith 2007; Platt 2014), while the benefits are not always clear. Creating meaningful

opportunities for students to reflect is hard, and real, visible impact for students is far from guaranteed. Without tackling these challenges reflection will remain an afterthought in engineering education, rather than an integrated activity.

3 THREE MAIN ELEMENTS OF STRUCTURAL ATTENTION FOR REFLECTION

Schaepkens and Lijster (2022) argue that meaningful reflection needs to bridge two gaps: 1) the gap between theory and practice and 2) the gap between an individual and their community (p.3). Schaepker and Lijster follow Kant in arguing that reflection resists systemization and can not be taught: it can only be practiced as reflection needs a context and there are no definite rules that can address all contexts. Additionally, individuals and communities always change, so the gap between individual and communal sense requires a continuous dialogue, not a set of rules. However, without structural attention for practicing reflection students will not develop skills to reflect on their praxis in a meaningful way. Our university initiated an institution-wide program that recognizes the importance of reflection and aims to embed meaningful reflection in our engineering curricula. In this section we describe four main elements of our program.

Element 1: There are many ways to do reflection

Within the program we do not advocate 'one right way' for reflection. Instead, we aim to create a vision of the possible role and use of reflection in engineering education that leaves enough room for instructors to adapt to specific contexts. The program aims to be supportive, not prescriptive, to instructors who wish to integrate reflection in their courses. We see reflection as a process in which engineers stop and take time to use their thoughts and feelings to make sense of an experience or issues, and to yield insight into themselves and into how they relate to the world around them so that they can grow and/or change their actions. There is no shortage of literature about how to “do” reflection, originating from a variety of research fields, such as education, psychology, healthcare, management and philosophy (Mina, Cowan, and Heywood 2015; Fleck and Fitzpatrick 2010; Gordijn et al. 2018; Keestra 2017; Marshall 2019). We do not oppose any models these authors propose and our practice of reflection is not a substitute. Yet, instead of prescribing one way to ‘do’ reflection, we provide information, structure, vocabulary, and awareness to instructors to make an informed choice in the use and purpose of reflection.

Element 2: Six domains of reflection

We frame reflection in the context of engineering education and distinguishing six domains to reflect on. That way reflection becomes a concept that instructors and students can grasp more easily. The six domains were identified through an institution-wide exploration of what reflection is (Hermsen et al., 2022). These six domains are:

1 - Society: reflection on social themes and challenges. For example, climate change, inclusion and equity, affordable healthcare, sustainable infrastructure and mobility, energy transition, circular economy, and others.

2 - Product: reflection on the various stages of developed models, prototypes, policies, procedures, services and /or research. For example, on weighing requirements, balancing impact, the value, and limitations, etc.

3 - Process: reflection on the (sub)conscious choices made in the process and the way they influence outcome. For example: going over activities, looking at blind spots and assumptions, examining successes and mistakes.
4 - Interaction and collaboration: reflection on interactions and collaboration with peers or supervisors. Reflection on for example to understand others, prevent, manage, and solve conflicts.
5 - Learning: reflection on learning strategies, assessments, ambitions, attitudes, targets, motivation, personal development, and ownership of learning.
6 - Oneself: reflection on one's behavior and perceived identity, for example on personal contexts, standards, beliefs, values, convictions, biases, and privileges.
The domains help structure reflection and facilitate comprehension rather than create isolated areas that confine reflection. In practice these domains are interwoven, and sometimes overlap. Labeling the domains provides vocabulary to enable comprehensive dialogue on what to reflect on.
The domains are depicted in Figure 1A.

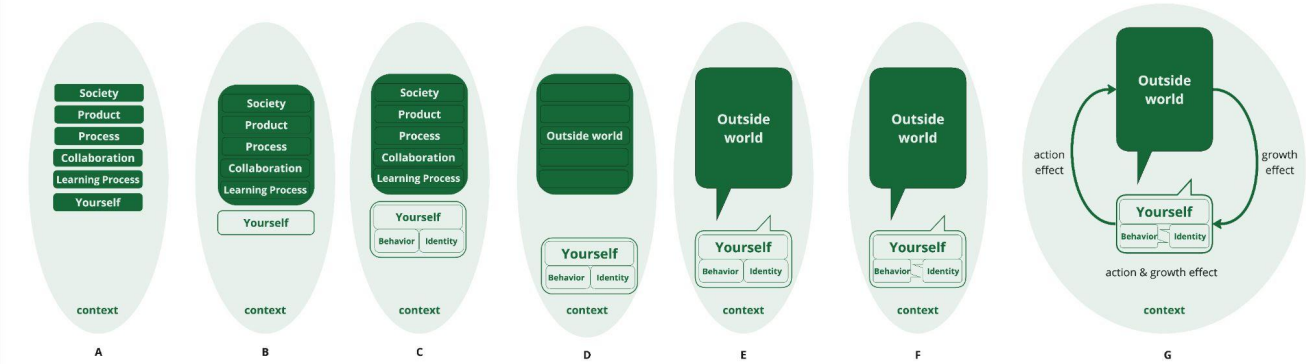

Figure 1 Visualization of (transformative) reflection

Element 3: Contextualization of reflection
Meaningful reflection happens in a context, not in a vacuum. As reflection needs to bridge the gap between the individual and their community it is important to be aware of knowledge, experience, mental models, interpretations, norms, culture, and values assigned to reflection by individuals, sections, departments, faculties, and educational programs that are present in the community. Leaders who prioritize reflection and create space for experimentation and for learning from failure foster a different environment than those who enforce strict control (Maarel 2016; Laloux 2016). For example, reflection on mistakes will be different in a department that frequently discusses mistakes, compared to a department that never discusses them. Finally, there are many practical context-dependent factors to take into account, as discussed above. These include, yet are not limited to, creating time, space, and a setting to create conditions for meaningful reflection to happen.

Element 4: Transformative reflection
Thirdly, we aspire to deepen reflection into *transformative* reflection. As mentioned before, superficial reflection is not uncommon, yet we aim for reflection that is able to initiate change, by contextualizing, enriching, and augmenting the reflective activity. The word 'transformative' is informed by the Oxford Advanced Learners' Dictionary that describes it as "causing or able to cause change", and by scholars like Kitchenham and Mezirow who have worked on transformative learning (Kitchenham

2008; Mezirow 2000) and contributions to the Journal of Transformative Learning, e.g. Minnes et al. (2018) and Scheele (2015). Based on these contributions we see transformative reflection as going through a process of reflection that is causing or is able to cause change in learners' points of view, frames of reference or habits of mind and how learners experience, conceptualize and interact with the world. Change can be small; for example, something suddenly making sense. Change can be big(ger); for example, a behavioral change is initiated. Transformative reflection can occur naturally or through a designated activity, yet not all reflective exercises we design for students are transformative (de la Croix and Veen 2018).

4 TRANSFORMATIVE REFLECTION IN PRACTICE

Transformative reflection cannot be forced, yet we find that we can design meaningful activities that create opportunities for this type of learning. We established three steps that need to be present in meaningful reflection activities.

Step 1: Distinguish and link multiple reflection perspectives
Figure 1B shows that our external reflection perspective is influenced by our internal reflective perspective. If we relate to or interact with the world, we always take ourselves with us. The external perspective is shaped by community expectations and outside requirements. Code-switching[3] (McCluney et al. 2019) is an example that demonstrates this principle. One consciously or subconsciously adapts one's behaviour to fit in different social or cultural situations. Figure 1C shows that the internal perspective consists of our perceived identity and our behaviour. Identity and behaviour may not always align and can vary depending on the situation. To design a transformative and reflective activity, it is important to incorporate both the personal perspective (ourselves) and perspectives that exist in the outside world.

[2] Code switching is the way in which a member of an underrepresented group (consciously or unconsciously) adjusts their language, syntax, grammatical structure, behavior, and appearance to fit into the dominant culture.

Step 2: Facilitate a dialogue between internal and external perspectives.
Understanding and seeing links between the six reflection domains and reflection perspectives is not enough. For reflection to become meaningful or transformative, we need a process that *facilitates an interaction* between ourselves and our perspective and the world outside of us: we create this interaction using the following four mechanisms.

Step 2.1: Create distance between ourselves and other domains.
First, we disentangle the domain of "Self" from the five other domains and create distance. By doing this we create the opportunity to define internal and external perspectives. Separating the internal perspective from external expectations creates space to consider multiple external aspects without the need to deal with them immediately. This also creates space to look at ourselves without expectations or judgements that are imposed by yourself or the world outside.

Step 2.2: Point out the gap between the internal and external perspectives and review each in isolation.
Now that we have created distance between the outside perspectives and ourselves, there is space to explore multiple possible interpretations or perspectives on the

issue at hand with a curious and open mind. Questions to explore include: what are the ways that other people regard the situation? How do other people or cultures deal with this? What are blindspots? What could be unintended side effects of choices made? How did the other person experience the collaboration? What other things could be learned in this course? Could there be different intentions than mine? Or: if I try to look at myself without judgment, what do I see? Mechanisms 2.1 And 2.2 are represented in Figure 1D.

Step 2.3: Create a 'dialogue' (tension) between inner and outer perspective.
Switching between internal and external perspectives creates a 'dialogue' which can provide a new perspective, or may provide insight into your position. This insight might change the way you perceived something previously. For example: suppose you were annoyed that one group member worked fewer hours than the others. By exploring reasonable causes of this behaviour, you might realize that there are many reasons for this behaviour to be acceptable, e.g. suffering a loss, being sick, taking care of family, having financial problems etc. This might not only give you a new perspective on the conflict, yet it might also give you some insight in that having no external responsibilities or no financial problems are a privilege that you enjoy. Subsequently, this insight might affect the way you handle a similar conflict; you might enquire with a person about the reasons behind it and be more empathetic. Going back and forth, adopting other views or perspectives, provides insight into the unknown parts of you or any blind spots (Luft and Ingham 1955) and it will change the way you relate to the outside world. This mechanism is represented in Figure 1E.

Step 2.4: Creating a second 'dialogue' between identity and behaviour
Transformative reflection requires a second dialogue between identity and behaviour. By examining and addressing the way we see ourselves in relation to our actions, we gain insights into our values, beliefs, and norms and/or in new ways to move forward. Building on the example of a group project conflict: the insight in that your work behaviour in this group is not only the result of your hard work, yet also of your financial and social circumstances might warrant the belief you are a 'hard worker', and it might also change the way you act when others are not pulling their weight. Or it might point you towards the realization you find it really difficult to act in such situations and that you need to work on your communication skills. This mechanism is represented in Figure 1F.

Step 3: Appreciate reflection for action and growth.
As the examples in the descriptions of the mechanisms illustrate, we differentiate between two reflection effects: reflection for action (What can I do differently?) and reflection for growth (What do I learn about myself or about how I see the world around me?) Taking time within the reflection activity to acknowledge the effect that the reflection has, supports consolidation of that effect. This mechanism is represented in Figure 1G.

5 DISCUSSION AND CONCLUSIONS

Today's wicked problems require engineers to be able to deal with the unknown and work across disciplines. This requires skills beyond the traditional boundaries of the engineering domain, such as social and ethical awareness, empathy and collaborative skills. Reflection is a prerequisite skill to those transversal skills, and

reflective skills enable engineers to notice and adapt to what is needed. Although reflection is widely regarded as important for engineers, its applications and the way it is taught generally has a narrow scope. Moreover, reflection skills are assumed to develop naturally. However, we found reflection requires structured attention, and specific instructional design.
We contextualize reflection as a tool in engineering and present prerequisites and mechanisms to design for deep, transformative reflection. Our approach complements existing reflection models. We attempt to initiate a fundamental change in how we design reflection in (engineering) education by moving towards emergence, instead of plug-and-play best practices. The six domains, perspectives and effects of reflection help engineering students and instructors understand how our perspectives influence how we relate to and influence the world.

Intuitively, the combination of reflection on the outside world to improve action fits well with engineers, as engineers tend to be analytical ‘problem solvers’, creators, designers and manufacturers. Contemplative reflection of the internal perspective for personal growth might be less intuitive, yet is crucial to develop proficiency in this skill (Hermsen 2022; Marshall 2019; Schön 1983).

We are aware many authors and practitioners already use elements of reflection we mentioned in this contribution. However, to our knowledge, there are no other publications that look at the contextualisation of reflection as a tool, or describe instructional design principles for transformative reflection. There might be other ways to design transformative reflection, yet the work presented here is our attempt to facilitate the process. The presented construct provides structure and key mechanisms for designing transformative reflection. However, it is not a foolproof step-by-step plan for designing effective reflective activities. Further experimentation with the model is needed.

The narrative feedback from students and instructors who participated in transformative experiential education is highly positive. They gain insights into themselves and others and see new ways forward and they value reflection higher. We are currently studying the impact of our transformative education in systematic ways. The work presented in this paper aims to raise discussion on the role of reflection in engineering education and leaves us to question how to scale up and make transformative reflection accessible to instructors.

REFERENCES

Akbari, R. 2007. "Reflections on reflection: A critical appraisal of reflective practices in L2 teacher education." System 35 (2):192-207. doi: 10.1016/j.system.2006.12.008.

Australian Council of Engineering Deans. 2021. "Engineering change: the future of engineering education in Australia."

Barak, Moshe. 2006. "Instructional principles for fostering learning with ICT: teachers' perspectives as learners and instructors." Education and Information Technologies 11 (2):121-135. doi: 10.1007/s11134-006-7362-9.

Beard, C., S. Clegg, and K. Smith. 2007. "Acknowledging the affective in higher education." British Educa,onal Research Journal 33 (2):235-252. doi:

10.1080/01411920701208415.

Bharuthram, S. 2018. "Reflecting on the process of teaching reflection in higher education." Reflective Practice 19 (6):806-817. doi: 10.1080/14623943.2018.1539655.

Boud, D., R. Keogh, and D. Walker. 1985. "Reflection: Turning experience into learning." Reflection: Turning Experience into Learning. London, Routledge.

Chan, C. K. Y., and K. K. W. Lee. 2021. “Reflection literacy: A multilevel perspective on the challenges of using reflection in higher education through a comprehensive literature review.” Educational Research Review 32. doi:

10.1016/j.edurev.2020.100376.

Chan, C. K. Y., H. Y. H. Wong, and J. Luo, 2021. “An exploratory study on assessing reflective writing from teachers’ perspectives”. Higher Education Research and Development 40 (4):706-720. doi: 10.1080/07294360.2020.1773769.

Churchman, C. West 1967. “Guest Editorial: Wicked Problems’. Management Science, Vol. 14(4): B141-B142

Cocon, A. H. 2001. "Private thoughts in public spheres: Issues in reflection and reflective practices in nursing." Journal of Advanced Nursing 36 (4):512-519. doi: 10.1046/j.1365-2648.2001.02003.x.

McCluney, C.L., K. Robotham, S. Lee, R. Smith, M. Durkee 2019. “The Costs of Code-Switching”. Accessed May 9th 2023..

hcps://hbr.org/2019/11/the-costs-of-codeswitching.

De la Croix, A., M. Veen (2018). “The reflective zombie: Problematizing the conceptual framework of reflection in medical education”. Perspectives on Medical Education 7(6): 394-400. doi: 10.1007/s40037-018-0479-9.

Fleck, R., G. Fitzpatrick 2010. “Reflecting on reflection framing a design landscape.” In Proceedings of the 22nd Conference of the Computer-Human Interaction Special Interest Group of Australia on Computer-Human Interaction, 216- 223.

Gordijn, F., N. Eernstman, J. Helder, H. Brouwer 2018. “Reflection methods: practical guide for trainers and facilitators: Tools to make learning more meaningful”. Wageningen Centre for Development Innovation.

Grant, M.J., and A. Booth. 2009. “A Typology of Reviews: An Analysis of 14 Review Types and Associated Methodologies.” Health Information and Libraries Journal 26 (2): 91–108. https://doi.org/10.1111/j.1471-1842.2009.00848.x.

Gürdür Broo, Didem, Okyay Kaynak, and Sadiq M. Sait. 2022. "Rethinking engineering education at the age of industry 5.0." Journal of Industrial Informa,on Integra,on 25:100311. doi: hcps://doi.org/10.1016/j.jii.2021.100311.

Hermsen, P., R. Rooij, G. Rijnbeek, T. Adrichem 2022. "Reflection in Engineering Education. White paper ‘100 DAYS OF… Reflection'."

Hirsch, Penny L, and Ann F McKenna. 2008. "Using reflection to promote teamwork understanding in engineering design education." International Journal of Engineering Education 24 (2):377.

Hobbs, V. 2007. "Faking it or hating it: Can reflective practice be forced?" Reflective Practice 8 (3):405-417.

Keestra, Machiel. 2017. "Metacognition and Reflection by Interdisciplinary Experts: Insights from Cognitive Science and Philosophy." Issues in Interdisciplinary Studies (35):121- 169.

Kember, D., J. McKay, K. Sinclair, and F. Kam Yuet Wong. 2008. "A four-category scheme for coding and assessing the level of reflection in written work." Assessment and Evaluation in Higher Education 33 (4):369-379. doi: 10.1080/02602930701293355.

Kinkhorst, Geert F. 2010. "Didactische ontwerpregels voor reflectieonderwijs." Onderwijsinnovatie 2010 (1):17-25.

Kitchenham, A. (2008). "The evolution of John Mezirow's transformative learning theory." Journal of transforma,ve education 6 (2):104-123.

LaBoskey, Vicki Kubler. 1994. Development of reflective practice: A study of preservice teachers: Teachers College Press New York.

Laloux, Frédéric. 2016. Reinventing Organiza,ons, An Illustrated Invita,on to Join the Conversation on Next-stage Organiza,ons: Nelson Parker.

Lönngren, Johanna. 2017. "Wicked problems in engineering education: preparing future engineers to work for sustainability." Chalmers tekniska högskola.

Maarel, Sandra van der 2016. "Slow down to speed up." In The New Leadership, edited by Twan van de Kerkhof, 167-177. European Leadership Platform.

Marshall, T. 2019. "The concept of reflection: a systematic review and thematic synthesis across professional contexts." Reflective Practice 20 (3):396-415. doi:

10.1080/14623943.2019.1622520.

MIT 2022. "Mission statement MIT." Last Modified October 22th 2022, accessed May 3rd. hcps://policies.mit.edu/policies procedures/10-ins2tute/11-mission-and-objec2ves.

McIntosh, Paul. 2010. “Action research and reflective practice: Creative and visual methods to facilitate reflection and learning”. Routledge.

Meijers, A.W.M., C.W.A.M. van Overveld, and J.C. Perrenet. 2005. “Criteria for Academic Bachelor’s and Master’s Curricula,” no. 2005: 1–23.

Meijers, F., and Mittendorf, K. 2017. "Zelfreflectie in het hoger onderwijs."227. Mello, Mello, L. V., and G. Wattret. 2021. "Developing transferable skills through embedding reflection in the science curriculum." Biophysical reviews 13 (6):897-903.

Mezirow, J. 1998. "On critical reflection." Adult Education Quarterly 48 (3):185-198. doi: 10.1177/074171369804800305.

Mezirow, J. 2000. “Learning as Transformation: Critical Perspectives on a Theory in Progress”. The Jossey-Bass Higher and Adult Educa,on Series: ERIC.

Mina, Mani, John Cowan, and John Heywood. 2015. "Case for reflection in engineering education-and an alternative." 2015 IEEE frontiers in education conference (FIE).

Minnes, M., Mayberry, J., Soto, M., Hargis, J. 2017. “Practice Makes Deeper? Regular Reflective Writing during Engineering Internships”. Journal of Transformative Learning, 4(2), 7-20.

Platt, Louise. 2014. "The ‘wicked problem’ of reflective practice: a critical literature review." Innovations in Practice 9 (1):44-53.

Ryan, Mary. 2013. "The pedagogical balancing act: Teaching reflection in higher education." Teaching in higher education 18 (2):144-155.

Schaepkens, Sven Peter Charlotte, and Thijs Lijster. 2022. "Mind The Gap: A Philosophical Analysis of Reflection’s Many Benefits." Teaching and Learning in Medicine:1-10.

Scheele, P. (2015). Transformative Learning in Higher Education: Praxis in the Field of Leadership and Change. Journal of Transformative Learning, 3(1), 5-12.

Schön, D. A. 1983. "The reflective practitioner: How professionals think in action." The Reflective Practitioner: How Professionals Think in Action.

Schuelke-Leech, Beth-Anne. 2020. "The place of wicked problems in engineering problem solving: A proposed taxonomy." 2020 IEEE International Symposium on Technology and Society (ISTAS).

Tsingos, Cherie, Sinthia Bosnic-Anticevich, and Lorraine Smith. 2014. "Reflective practice and its implications for pharmacy education." American journal of pharmaceutical education 78 (1).

Turns, Jennifer A, Brook Sacler, Ken Yas Yasuhara, Jim L Borgford-Parnell, and Cynthia J Atman. 2014. "Integrating reflection into engineering education." 2014 ASEE Annual Conference & Exposition.