Identifying teaching approaches for the USE learning line ‘**Responsible Innovation in a Global Context**’

Innovation Fund – Final deliverable

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# Introduction

This report explores the suitability of context-based teaching approaches for the new USE learning line ‘Responsible Innovation in a Global Context’ and is funded by the Innovation Fund of the Eindhoven University of Technology.

The report is broadly structured into two parts. The ensuing chapter 2 provides an exploration of teaching strategies which were used as inspiration and input for the development of the USE learning line ‘Responsible Innovation in a Global Context’. Special focus was put on teaching strategies which integrate formal education and relevant contexts. This exploration is based on both academic and grey literature, as it aims to provide practical insights about context-based education. Subsequently, chapter 3 shows how insights from the literature review have helped to shape the learning line ‘Responsible Innovation in a global context’ as a whole, as well as the three individual courses of which it consists. The learning line will be implemented in September 2018 and is, thus, still in development. Hence, this document presents a current state of the learning line’s design and not its final version.

# Teaching approaches and forms of assessment – a literature review

## Introduction

The aim of this chapter is to identify didactic approaches in which university education is taken to the outside context or the outside context is brought inside the university. This includes the identification of appropriate ways of assessing the success of the didactic intervention as well as the learning outcomes of a course or curriculum.

As these didactic approaches need to be relevant for the development of the learning line, section 2.1 will give a brief overview of the context in which this project takes place. The context sketched provides an overview of the fundamental ideas and prominent issues which shape the development of the USE learning line ‘Responsible Innovation in a global context’. After a discussion of the context, this section will conclude by presenting the methodology used for the literature review. Section 2.3 of this chapter explores context-based learning approaches inside the classroom and outside the classroom. In order to provide a coherent overview of different teaching approaches, the analyses will all be structured along the same set of categories, derived from the curricular spider web devised by Van den Akker (2003). A brief introduction to the curricular spider web will be given in section 2.2. Following the analyses of context-based cases in section 2.3, sections 2.4 and 2.5 will pay special attention to two of the categories of the curricular spider web: teacher roles and assessment methods. These two themes are highlighted because they merit close consideration when designing any course, but they have proven to be especially elusive when it comes to context-based education. Section 2.6 will provide a summary of the main insights about context-based learning gained in this report.

### A focus on User, Society, and Enterprise at the TU/e

At the Eindhoven University of Technology (TU/e), all students of any Bachelor of Science-programme are required to take User, Society, and Enterprise (USE) courses as part of their core curriculum. The aim of these courses is to educate so-called ‘T-shaped’ engineers: engineers who not only have in-depth disciplinary knowledge, but who also possess the competences necessary to understand problems as part of a larger system, the solution of which requires them to cross the boundary of their discipline and to work together in flexible, multi-disciplinary teams (Barile, Saviano, & Simone, 2015).

At the TU/e, the aim to educate ‘T-shaped’ engineers translates to the following USE curriculum goals (Meijers & Bombaerts, 2016):

1. *Students have a clear notion of user, society and enterprise, in relation to technology.*
2. *Students have knowledge of some of the concepts, tools, and methods in the humanities, social sciences or management sciences, needed to understand (explain, model) and evaluate (instrumentally, ethically) the multiple interactions between technology, user, society, and enterprise.*
3. *Students are able to apply that knowledge in the design, development and evaluation of technologies.*
4. *Students are able to take a well-argued stance on user, society and enterprise aspects of technologies.*
5. *Students are able to reflect on the development and responsibilities of the engineering profession.*
6. *Students are able to work in multidisciplinary teams and to reflect on the contribution of team members and of the various disciplines involved.*
7. *Students are able to communicate the results of their work to societal stakeholders (broadly conceived).*
8. *Students are motivated to take USE aspects into account when developing technologies.*

The USE curriculum goals are operationalized in a series of four courses, which starts with the USE base introductory course and concludes with a three-course USE learning line. As of academic year 2017-2018, the students have a choice of 13 USE learning lines. Each learning line revolves around a specific topic which relates to at least one of the three core perspectives of the USE curriculum; User, Society, and Enterprise (TU/e, 2017).

The USE curriculum was introduced as part of the Bachelor College in 2012, and during its first five years it has been generally well-received by educators and students. Nevertheless, evaluation of the USE curriculum has uncovered several challenges which many of the USE courses face (Meijers & Bombaerts, 2016). The main questions which need to be addressed according to Meijers & Bombaerts (2016) are the following:

* *How can the intrinsic motivation for USE learning lines be increased?*
  + *How can the rigor & relevance of USE learning lines be increased?*
* *How can the operationalization of the learning goals be improved?*
* *How should the wide diversity, in both learning styles and backgrounds, of teaching staff and students, be dealt with?*

The development of the USE learning line ‘Responsible Innovation in a Global Context’ provides an opportunity to tackle the issues identified by Meijers & Bombaerts (2016) by strategically implementing suitable teaching methods.

### A quick scan of interdisciplinary engineering education literature

An quick scan of literature about the design of interdisciplinary engineering curricula, and specifically about the challenges relating to rigor and relevance, provides several insights which can serve as a springboard for a more extensive literature review.

Spelt et al. (2009) define interdisciplinary thinking as “*the capacity to integrate knowledge of two or more disciplines to produce a cognitive advancement in ways that would have been impossible or unlikely through single disciplinary means”* (p. 365). In order to train students in this type of thinking, it is important to create an overarching framework which connects disciplinary and interdisciplinary knowledge and skills. This framework can be used to strengthen coherence of an interdisciplinary curriculum and the relevance of the individual courses within the curriculum (Spelt, Biemans, Tobi, Luning, & Mulder, 2009). Furthermore, Spelt et al. (2009) state that interdisciplinary learning tasks should actively encourage students to apply their knowledge about different disciplines, rather than ask them to memorize facts, as this will help them develop an appreciation of ambiguity. Engineering students need to develop skills for dealing with ambiguity or uncertainty since in the real world problems are generally ill-structured, while engineering education primarily trains students to solve well-defined problems (Ba-Aoum, 2016). ‘Real life’ partners, such as government institutions or companies, can provide interesting ill-structured projects for engineering education (Subrahmanian, et al., 2003). In such a set-up, academic and practice settings both bring their own contributions to the table. A consideration for the integration of academia and practice is to utilise the key strengths of each setting (Billett, 2009). In order to assess whether students have progressed in their ability for interdisciplinary thinking, assessment methods need to include both development and performance indicators (Spelt, Biemans, Tobi, Luning, & Mulder, 2009).

### Context-based learning

Context-based didactic approaches are well-suited to addressing the insights from the quick scan of literature as well as the issues presented by Meijers & Bombaerts (2016). Context-based education is specifically suited to addressing the issues with intrinsic motivation. In addition, context-based didactic approaches complement the USE curriculum goals well, and can help to operationalize them.

Context-based learning has its origins in the ideas of philosopher John Dewey, who in the late 19th century wrote about the importance of connecting the experiences students have outside of the classroom to the education they are receiving within the classroom (Smith, 2002). Connecting the social reality of students to their formal education increases the perceived relevance of courses and helps students to aggregate the information from individual courses into a coherent pool of knowledge. These results in turn increase the understanding of the subject matter of a specific course or curriculum (Pilot & Bulte, 2006b). Furthermore, placing conceptual questions in the right context allows students to experience the larger systems in which these questions exist, and enables them to evaluate a problem from different perspectives (King, 2016) and subsequently develop skills for dealing with ambiguous or ill-structured problems.

### Methodology

Within the realm of context-based learning, there is a wide variety of specific definitions and examples of learning processes and teaching methods (White, 2005). This chapter does not aim to provide an academic definition of context-based learning approaches. Instead, as stated in the introduction, it takes a practical approach to *identifying* didactic approaches in which university education is taken to the outside context or the outside context is brought inside the university, as well as identification of appropriate ways of *assessing* the success of the didactic intervention as well as the learning outcomes of a course or curriculum.

The identification of didactic approaches and assessment methods is done through a review of relevant texts, which are not limited to academic sources; the report includes other sources which present a broad overview of a relevant case in which context-based teaching methods were applied. The USE curriculum issues described by Meijers and Bombaerts (2016), especially the issues relating to intrinsic motivation, were used as a lens to select the cases described in this report. Additionally, cases were selected based on their content in order to increase their applicability to the USE learning line ‘Responsible Innovation in a Global Context’. Cases were only included if they described context-based teaching methods for society, science, or technology education. Finally, the intent was to select cases which described tertiary education programmes. However, the majority of cases of context-based learning described in literature concern secondary education, and it was therefore not feasible to hold on to this criterion. This indicates that the deliberate application of context-based teaching approaches at a university level is a relatively novel idea which offers valuable new possibilities, both for practice and for research.

## The curricular spider web

According to Van den Akker (2003) a curriculum consists of 10 elements, which are all interconnected. At the heart of a curriculum is the *rationale*, and closely related are the *aims and objectives*, and the *content* of a curriculum. Any changes to these three elements usually lead to changes in the rest of the elements as well. To represent this interconnectedness, Van den Akker (2003) visualised a curriculum as a spider web; when you pull on one end of the web, the rest of the spider web moves as well. A graphic representation of this can be seen in Figure 1.

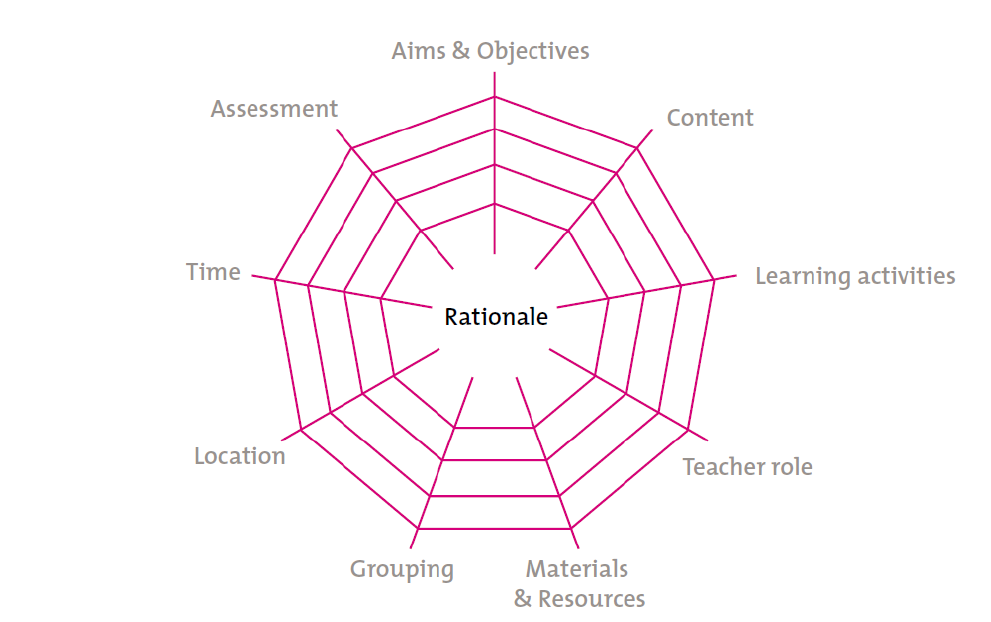


Figure 1: The curricular spider web (Van den Akker, 2003)

The ten components of a curriculum, which are each represented by a thread of the curricular spider web, will be used in chapter 3 of this report to structure the different learning approaches in a uniform manner.

## Context-based learning approaches

The six teaching methods described in this section bring contexts into the classroom or bring the classroom to the outside context. Each case approaches this in a different way, and the different approaches have different lessons which can help to address the USE curriculum issues, specifically the issues with intrinsic motivation, presented in the introduction of this report. Each case in this chapter is described separately, starting with the main lessons to be learned, followed by a general description of the case and an overview of the learning activities structured along the lines of the curricular spider web presented in section 2.2.

### In the classroom: Teaching citizenship through a board game

This case shows how context-based education inside the classroom can let students experience the complexities of societal issues, and how it teaches students to entertain different viewpoints when assessing a problem and forming an opinion. A teaching method as the one described in this case can therefore help with the operationalization of the USE curriculum goals, specifically goals 1, 2, 4, 5, and 8[[1]](#footnote-1).

#### Case description

Visser (2017) argues that the Dutch educational system does not shape critical citizens. Whilst receiving primary and secondary education, students are often told what is right and what is wrong instead of being presented with ethical questions which help them shape their own morality. As a result, students know what they ought to think, but do not know why they think it. This makes them impressionable, and susceptible to persuasive people instead of persuasive arguments. Instead of telling students what to think, education should encourage students to develop their own insights (Visser, 2017).

Because he feels traditional education fails to teach citizenship, Visser (2017) highlights a novel learning activity developed specifically for this purpose, and which he observed in action. The educational tool Visser describes is a board game called Terra Nova, which was developed by designer Lisa Hu, and can be used in primary, secondary, and tertiary education. Terra Nova is designed to introduce abstract concepts such as democracy and solidarity, as well as to demonstrate how difficult it is to find a balance between individual and collective interests in society (Hu, 2017).

During the course of a game, players design their own society from scratch on a fictional uninhabited island. After setting up their society and deciding whether or not to appoint a leader, the game master presents the players with social issues which they have to solve as a group. These issues are inspired by real societal problems, and resolving them invariably leads to ethical discussions which mirror discussions in real life.

An overview of this teaching method as described by Visser (2017), structured along the categories of the curricular spider web presented in section 2.2 of this report, can be found in

Table 1: Terra Nova, structured along the categories of the curricular spider web.

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#### Table 1: Terra Nova, structured along the categories of the curricular spider web.

|  |  |
| --- | --- |
| **Rationale**  Why are they learning? | Instead of telling students what to think, educators need to enable them to discuss ethical issues and come to their own insights with respect to morality. This will teach students to be critical citizens, who not only have opinions but also know why they have these opinions. |
| **Aims and objectives**  Towards which goals are they learning? | The objective of the game aim is to familiarize students with abstract concepts such as democracy, solidarity, and equality, and to show them how difficult it can be to find a balance between individual and collective interests in a society. Furthermore, the game aims to let students engage in group discussions about these issues which, while fictional in the game, mirror real-life societal issues. |
| **Learning activities**  How are they learning?  **Materials and resources**  With what are they learning?  **Grouping**  With whom are they learning?  **Location**  Where are they learning?  **Time**  When are they learning? | Students are split up into groups of five. Each group gets a game board with an empty island on it, ten wooden ‘Islander’ pawns (three of which are children), two palm trees, three coconuts, three fresh water lakes, and three settlements.  The first task of the group is to give each component its place. Then the group has to decide whether or not they want leaders for their island community, and if so how many. Once they have decided on a leadership structure for the island, the groups are presented with a succession of situations which the group has to resolve by composing island laws. Examples of situations are:   * One islander has caught two very big fish. Does he have to share his catch with the rest, or can he keep the fish to himself? * An islander is too sick to work. Does the rest of the community provide food for the sick islander? If so, for how long? * The coconut machine you built on your island caused a flood on another island. The people from the other island want to seek refuge on your island. What do you do?   One class can play the game seven times. The basic structure of the game is the same, but the game master can focus on a different theme each time; for example solidarity, being different, or sustainability. This allows students to continue the development of their societies. |
| **Teacher role**  How is the teacher facilitating their learning? | The role of the teacher, or game master, is to enable discussions without steering them. This can be difficult when students come to a consensus which is not in line with what the teacher wants to teach; for example when students collectively decide to deny all refugees entry onto their island because they think the refugees might have malicious intentions.  In such a situation, a game master can reopen the discussion about a topic by asking open questions to help clarify the rationale behind a thought or decision. |
| **Assessment**  How is their learning assessed? | Students are not assessed individually. At the end of the game, the game master brings all the groups of players together to aggregate the insights which they gathered while they played Terra Nova. Finally, students are encouraged to come up with a project which will make the real world a little bit more like their fictional world. |

Visser (2017) notes that, after an hour of observations, he has heard many and different ethical discussions arise in the group of primary school students playing Terra Nova. Ultimately, with guidance of the game master, most groups of players end up with an inclusive society in which individual people may have to make small concessions to ensure that everyone on the island is cared for. This illustrates that **students have learned to take other views than their own into account** **when approaching societal issues**, which indicates that they have developed their ability to address ambiguity or uncertainty.

What is interesting in terms of the used contexts, is that Visser (2017) argues it is beneficial to the ethical discussions among students that the game is set in a real-adjacent context, and not in a real context. Discussions about refugees are less fraught with pre-existing assumptions when the refugees are not from the Middle East or Africa, but from a fictional island.

### In the classroom: Context-based chemistry kits

This case shows how context-based education inside the classroom can increase the perceived relevance of conceptual knowledge for students, and thus increase students’ intrinsic motivation to acquire said knowledge. A teaching method as the one described in this case can therefore help to address the challenges with intrinsic motivation faced in the USE curriculum.

#### Case description

The German government-led initiative “Chemie im Kontext” encourages teachers to implement context-based learning activities in high-school chemistry education, with the aim of honing students’ questioning and reasoning skills as well as teaching them scientific principles. Since the introduction of “Chemie im Kontext” in the 1990s, experience has shown that the successful implementation of context-based learning activities depends heavily on the teachers’ efforts and enthusiasm about the method (Fechner & Sumfleth, 2016).

In order to increase the successful uptake of context-based learning environments in chemistry curricula, the “Chemie im Kontext” programme developed ready-to-use science kits with the help of high school chemistry teachers. In their book chapter, Fechner and Sumfleth (2016) describe the implementation of a set of five science kits which all relate to acid-and-base chemistry. These science kits, which contain pre-selected equipment and student assignments, can be integrated into a chemistry curriculum as single units or as a whole.

It is important to note that, in order to test the efficacy of context-based chemistry education in high schools, Fechner and Sumfleth (2016) did not follow the implementation of the science kits in a regular classroom. Instead, they invited students to volunteer for extra chemistry classes. The volunteer group was split into two; one group worked with context-based chemistry kits based on real-life contexts, while the control group worked with context-based chemistry kits based on laboratory contexts.

An overview of this teaching method as described by Fechner and Sumfleth (2016), structured along the categories of the curricular spider web presented in section 2.2 of this report, can be found in Table 1.

#### *Table 1: “Chemie im Kontext” science kits, structured along the categories of the curricular spider web.*

|  |  |
| --- | --- |
| **Rationale**  Why are they learning? | Context-based projects can help students in the acquisition of conceptual knowledge by creating a need for information; this principle is called “need-to-know” by Fechner and Sumfleth (2016), and according to them cultivates more in-depth understanding than traditional, teacher-centred teaching approaches. In addition, collaborative and inquiry-based projects can help students with the development of their questioning and reasoning skills. |
| **Aims and objectives**  Towards which goals are they learning? | Letting high school students acquire conceptual chemistry knowledge on a need-to-know basis through context-based projects. |
| **Content**  What are they learning? | The five kits are cumulative, and together build up students’ knowledge of acids and bases. |
| **Learning activities**  How are they learning?  **Materials and Resources**  With what are they learning?  **Grouping**  With whom are they learning? | "Chemie im Kontext" is based on three fundamental principles:   * 1. the unit has to incorporate a real life context,   2. the learning environment should support students in self-directed and cooperative learning, and   3. the real life context should enable students’ to acquire theoretical concepts by addressing conceptual knowledge and through 'decontextualisation'   Every single kit contains a problem, relevant information to address the problem, and the necessary equipment to conduct experiments. Furthermore, students are asked to take notes on the inquiry process into a lab book provided for each small student group. Through the different element, the science kits stimulate data gathering by students themselves, interpretation of the data through group discussion, and the integration of individual efforts into a group product. |
| **Teacher roles**  How is the teacher facilitating their learning? | Whether a context-based learning environment is successful depends on teachers' efforts. Despite the access to pre-existing, context-based science kits, teachers are the ones who determine the place of the science kits in the curriculum and implement them during their lessons.    During the activity, the teachers are active observers who monitor the progress of the individual students and the groups. Teachers only take an active role the communication on knowledge when necessary. |
| **Assessment**  How is their learning assessed? | For this study, control kits were developed in order to assess the efficacy of the context-based science kits. The control kits were developed using the same principles as the context-based kits. However, the problem was situated in the laboratory rather than in a real life context. A survey aimed at measuring student interest levels was conducted among all the participants, both in the control group and in the context group, right after finishing their revision exercises. It is not specified what these revision exercises were. |

Fechner and Sumfleth (2016) observe that student groups were capable of working with the science kits in an independent manner, allowing educators to take on their intended role as observers, and making implementation relatively easy.

Furthermore, Fechner and Sumfleth (2016) show that **students learning with real life contexts were more interested in both the learning activities and the subject matter** than the students in the control group were. In addition, in the execution of tasks students working with real life context kits outperformed the students in the control group in terms of conceptual understanding.

### Outside the classroom: Sustainability practices in an international context

This case illustrates how context-based education outside the classroom can let students experience the complexities of international issues such as sustainability, and how it teaches students to consider different perspectives when evaluating technology. The case also illustrates how context-based education can improve students’ attitudes towards complicated concepts such as sustainable development. A teaching method as the one described in this case can therefore help with the operationalization of the USE curriculum goals, specifically goals 1, 2, 3, and 8[[2]](#footnote-2).

#### Case description

Higher education institutions can contribute to sustainability transitions by impressing the importance of making sustainable choices in both personal and professional life on their students. Lee and Schottenfeld (2012) describe an example of education for sustainable development at a university level. In this project, a group of students from two different degree programmes within the School of Planning, Design and Construction at Michigan State University visited the World Expo 2010 held in Shanghai, China in order to learn about sustainability practices in the planning, design, and construction of buildings and cities in an international context.

An overview of this teaching method as described by Lee and Schottenfeld (2012), structured along the categories of the curricular spider web presented in section 2.2 of this report, can be found in **Error! Reference source not found.**.

#### Table 3: World Expo field trip, structured along the categories of the curricular spider web.

|  |  |
| --- | --- |
| **Rationale**  Why are they learning? | Higher education institutions could contribute to sustainability transitions through their educational programmes. The US government has therefore required higher education institutions to make sustainability literacy a core competence for all students. |
| **Aims and objectives**  Towards which goals are they learning? | The main objective of this project is to increase the sustainability literacy of participants. This includes a change in attitudes and values with respect to sustainability, and an increased ability to apply sustainability knowledge in practice. |
| **Content**  What are they learning? | Sustainability practices in the planning, design, and construction of buildings and cities in an international context. |
| **Learning activities**  How are they learning?  **Location and**  **Time**  Where and when are they learning? | There were two main learning activities in this case. The first activity was a series of classical lectures highlighting the planning, construction, and execution of large structures such as seen at the World Fair, within a framework of sustainable development. These lectures were planned before the trip, to prepare students for their assignments during the trip.  The second activity was a three-day visit to the 2010 World Expo in Shanghai, China. Here students were asked to identify and evaluate sustainability practices in the planning, design, and construction of several different pavilions. There were a few mandatory pavilion visits for the whole group, and additionally students were required to visit several pavilions of their own choice. |
| **Teacher role**  How is the teacher facilitating their learning? | Ahead of the trip, teachers were responsible for the organisation of the preparatory lectures. Additionally, they made it a point to encourage students to actively engage with sustainable practices to offset the negative environmental impact of international travel.  During the trip, teachers were responsible for the organisation and coordination of activities and lectures on site. This required flexibility and improvisation, because not everything could be arranged in advance. Teachers found that it was especially important to schedule enough time for reflection and organise discussion sessions about the experiences of the students. |
| **Grouping**  With whom are they learning? | The group consisted of 26 students from the School of Planning, Design and Construction; 15 students from the interior design programme and 11 students from the urban planning programme. The students visited different pavilions as a class or in smaller groups. |
| **Assessment** How is their learning assessed? | After the trip, students were asked to fill out a survey to ascertain whether the desired learning outcomes were achieved. The topics covered in the survey were: engagement, interest and inspiration; knowledge and understanding; attitudes and values; and behaviour, activity and progression. Of the 19 questions in the survey, 15 questions were answered on a Likert scale, two questions required a yes/no answer, and two questions were open-ended. No survey was conducted before the trip. |

Based on the survey they conducted after the project, Lee and Schottenfeld (2012) conclude that **the visit to China positively impacted students’ attitudes and values with respect to sustainability**. In addition, “*students recognized the importance of understanding cultural diversity and holding a global perspective on sustainable development.”* (Lee & Schottenfeld, 2012, p. 351)

### Outside the classroom: Building a curriculum around the local community

This case shows how context-based education outside the classroom can increase the perceived relevance of conceptual knowledge, and improve the intrinsic motivation of students to acquire said knowledge. In addition, this teaching method illustrates that it is possible to tailor education to fit students with diverse interests and learning approaches. A teaching method as the one described in this case can therefore help to the challenges with intrinsic motivation and diversity faced in the USE curriculum.

#### Case description

In the 1990s Francisco Guajardo, a high school teacher in the border town of Llano Grande, Texas, started an extracurricular programme to encourage his students, many of whom had a Latin American background, to apply to Ivy League universities. The programme was successful, and several of his students were accepted into prestigious schools. However, after a few years Francisco Guajardo noticed that not many of these highly-educated people were returning to their local community to play a role in its further development (Guajardo, 2015).

In order to strengthen his students’ bond with the local community, Guajardo started to include the community in his coursework. In the first year of this project, students were asked to talk to community members in order to hear the stories about how the community was formed (Llano Grande Center, 2017). Both the students and the community were so enthusiastic about the project that they repeated the process the year after. The extensive research into the background and culture of the community resulted in the identification of key community assets, which were in turn used for the development of the community and the education of its children (Smith, 2002).

An overview of this teaching method, structured along the categories of the curricular spider web presented in section 2.2 of this report, can be found in Table 2.

#### Table 2: Building a curriculum around the local community, structured along the categories of the curricular spider web.

|  |  |
| --- | --- |
| **Rationale**  Why are they learning? | Integrating the local community in a high school curriculum can strengthen the relationship between students and the community, increasing the chances that later in life students will want to play an active role in the development of their community (Guajardo, 2015). |
| **Aims and objectives**  Towards which goals are they learning? | The aim is to increase the connection and engagement of students with their community. Additionally, students are encouraged to play a positive role in the further development of the local community (Llano Grande Center, 2017). |
| **Content**  What are they learning? | The culture and stories of the immigrant community of Llano Grande, Texas (Guajardo, 2015). |
| **Learning activities**  How are they learning?  **Materials and resources**  With what are they learning?  **Grouping**  With whom are they learning?  **Location**  Where are they learning? | Students conducted individual and group interviews with older residents from their local community to talk about the culture of the community (Smith, 2002). Some of these people were notables of the community, but many of them were neighbours and family members of the students (Guajardo, 2015). The interactions with community members were documented through audio, video, and photographs, and with the collected materials the group of students mounted a public exhibit about their community (Smith, 2002).  A year later the project was repeated by a new class of students, and they started to notice reoccurring topics in the interviews they and their predecessors had conducted. The knowledge gained about the local community was used to adjust the course curriculum, making the course more relevant for this particular group of students (Smith, 2002). |
| **Teacher role**  How is the teacher facilitating their learning? | The teacher facilitated the project by organising and supervising the first interviews, which the students conducted as a group. The teacher used his social network within the community to facilitate the subsequent interviews which the students carried out (Guajardo, 2015). |
| **Assessment**  How is their learning assessed? | The students put together an exhibit with the video, audio, and photographical materials they gathered during their interactions with community members (Smith, 2002). It is not specified whether the quality of this exhibit was assessed in order to grade students. |

What is important to notice about this teaching method is that **the students themselves played a pivotal role not only in the creation of the content of their course, but also in the content of later versions of the course**. This requires a lot of flexibility on the part of the teacher.

### Outside the classroom: Guest lectures and site visits

This case shows how context-based education outside the classroom can increase the perceived relevance of conceptual knowledge for students, and thus increase students’ intrinsic motivation to acquire said knowledge. A teaching method as the one described in this case can therefore help to address the challenges with intrinsic motivation faced in the USE curriculum. Furthermore, this case shows how students can gain understanding of the engineering profession through the execution of engineering projects. A teaching method as the one described in this case can therefore help with the operationalization of the USE curriculum goals, specifically goals 4, 5, 6, 7, and 8[[3]](#footnote-3).

#### Case description

Vennix, Den Brok, and Taconis (2017) argue that the current knowledge-intensive economy needs professionals in Science, Technology, Engineering, and Mathematics (STEM) field who not only have in-depth knowledge in their respective field, but who also have so-called “21st century skills” (Vennix, Den Brok, & Taconis, 2017, p. 22). These skills include, but are not limited to, being flexible, knowing how to communicate effectively, and being able to work in multidisciplinary teams. To ensure there are enough STEM professionals with 21st century skills, Vennix, Den Brok, and Taconis suggest a two-pronged approach; 1) increasing the number of people pursuing a career in a STEM field by increasing motivation among students who would normally would not consider this, and 2) gradually building 21st century skills by introducing them in high school.

To increase the motivation to pursue a career in a STEM field among high school students, as well as to cultivate their 21st century skillset, Vennix, Den Brok, and Taconis (2017) propose involving the private sector in secondary education. Letting students interact with professionals in a STEM field places STEM education in a real life context, which increases the relevance of both the conceptual knowledge and the skills which students have to learn.

In their paper, Vennix, Den Brok, and Taconis (2017) review 12 different initiatives in which interaction between STEM professionals and high school students plays an important role. A condensed overview of the teaching methods as described by Vennix, Den Brok, and Taconis (2017), structured along the categories of the curricular spider web presented in section 2.2 of this report, can be found in Table 3.

#### Table 3: Guest lectures and site visits, structured along the categories of the curricular spider web.

|  |  |
| --- | --- |
| **Rationale**  Why are they learning? | The contemporary knowledge-intensive and technology-based economy needs STEM professionals with 21st century skills. Involving companies in high school education can increase the motivation of high school students to pursue a STEM career, and can help to cultivate the desired skills. |
| **Aims and objectives**  Towards which goals are they learning? | Motivating high school students for STEM careers, as well as cultivating skills such as being flexible, knowing how to communicate effectively, and being able to work in multidisciplinary teams. |
| **Content**  What are they learning? | Varying across the 12 initiatives, but always relating to Science, Technology, Engineering, and/or Mathematics |
| **Learning activities**  How are they learning?  **Location**  Where are they learning? | Among the 12 initiatives described, there were several different learning activities which connected students and STEM professionals. A key feature these learning activities is that STEM professionals provide insight into what it is like to work in their respective field. The activities include:   * Guest lectures from STEM professionals, in which they can relay what it is like to work in a STEM field, * Tours of companies and industrial laboratories where students see STEM professionals at work, and * Student projects assigned and monitored by STEM professionals, in which they simulate a project which a STEM professional might encounter, including the interaction with clients and the delivery of a final product. |
| **Teacher role**  How is the teacher facilitating their learning? | The role of the teacher in these cases is to facilitate the interaction between students and STEM professionals. How this is achieved depends on the specific learning activity. Vennix, Den Brok, and Taconis (2017) also state that, in general, it is the role of the teacher to provide a learning environment which satisfies the three dimensions of motivation: autonomy, competence, and relatedness. |
| **Assessment**  How is their learning assessed? | In the spirit of showing students what it was like to work in a STEM field, in the majority of the 12 initiatives students were asked to write a report about their project, and were sometime also required to present their findings. |

Vennix, Den Brok, and Taconis (2017) show that **the interest in STEM increased moderately to strongly among the participants of all 12 of the initiatives**. The most positively received initiative was a project in which students were taken on excursions to labs and companies to write and present a consultancy report.

### Side-by-side comparison: Assessing the health of a local creek

This case illustrates how context-based education outside the classroom can let students experience the complexities of issues such as the management of delicate ecosystems, and how it teaches students to consider different perspectives when evaluating a problem. In addition, this teaching method illustrates that it is possible to tailor education to fit students with diverse interests and learning approaches. A teaching method as the one described in this case can therefore help to address the challenges with diversity faced in the USE curriculum, and can help to operationalize the USE curriculum goals, specifically 1 and 8[[4]](#footnote-4).

#### Case description

Students in secondary education often have a difficult time relating the scientific concepts they learn in school to their daily lives, making them lose interest in science. Incorporating real life contexts into science classes can increase the perceived relevance of scientific knowledge, and can subsequently increase student engagement.

In chemistry education, water quality is a relevant and salient context which is used often, though the way in which contextual information about water quality is provided can differ between initiatives. King (2016) studied two groups of high school students who assessed the water quality of a local creek as part of their chemistry education. The one group of students stayed in the classroom and was given contextual information by the teacher, while the other group of students paid weekly visits to the creek.

An overview of both teaching methods as described by King (2016), structured along the categories of the curricular spider web presented in section 2.2 of this report, can be found in Table 4.

#### Table 4: Assessing the health of a local creek, structured along the categories of the curricular spider web.

|  |  |  |
| --- | --- | --- |
|  | **Weekly visits to local creek** | **Contextual information in class** |
| **Rationale**  Why are they learning? | Students in secondary education often have a difficult time relating the scientific concepts they learn in school to their daily lives, making them lose interest in science. Incorporating real life contexts into science classes can increase the perceived relevance of scientific knowledge, and can subsequently increase student engagement in science class. | |
| **Aims and objectives**  Towards which goals are they learning? | The aim is to teach scientific concepts relating to chemistry and environmental management to high school students. In addition, this course aims to show students the important role environment plays in a community. | The aim is to teach chemistry concepts and skills to students in their second to last year of high school. |
| **Content**  What are they learning? | Basic scientific concepts relating to ecology, environment, and water quality. | Scientific concepts and skills needed to assess water quality. |
| **Learning activities**  How are they learning?  **Materials and resources**  With what are they learning?  **Grouping**  With whom are they learning?  **Location**  Where are they learning?  **Time**  When are they learning? | This course was designed to be student-centred. This means scientific concepts were taught on a need-to-know basis, prompted by questions which arose as students worked through the project.    The project in this case was to assess the health of a local creek and its surroundings. In order to do so, students paid weekly visits to the creek, where they worked in groups to gather data by observing plant and animal life in and around the creek. Data was recorded in students’ journals and on video.  In addition to discussing their data back in the classroom, student groups were encouraged to discuss their observations and link what they were seeing to scientific concepts as they were seeing it. | This course was designed to be student-centred. This means scientific concepts were initially taught on a need-to-know basis, prompted by questions which arose as students worked through the project. Because of perceived time constraints and a slow progression through the planned curriculum in the first half of the course, the teacher switched to a more classical teacher-led approach for the second half of the course.  The project in this case was to assess the water quality of a local creek. The entire project was carried out by student groups through lab work in the classroom. Water samples and contextual information in the form of a map of sample collection sites were provided by the teacher. |
| **Teacher role**  How is the teacher facilitating their learning? | The teacher was responsible for creating learning environments which allowed the students themselves to connect the context they were observing to the scientific concepts which they learning.  In addition, the teacher provided conceptual information when students required it. Being a student-centred course, the teacher followed the lead of the students instead of the other way around. This required flexibility on the teacher’s part. | The teacher was responsible for creating learning environments which allowed the students themselves to connect the context they were given to the scientific concepts which they learning. In addition, the teacher was responsible for monitoring the progress in conceptual understanding of students.  Initially, the teacher provided conceptual information when students required it. However, as a result of perceived time limitations, the teacher adopted a more teacher-centred approach for the second half of the course. |
| **Assessment**  How is their learning assessed? | For both classes, student groups were required to write a report in which they drew conclusions about the health of the local creek based on the scientific evidence they gathered. The students were assessed based on the quality of these reports. | |

King (2016) does not elaborate on the level of conceptual understanding students managed to demonstrate at the end of their context-based classes, or on how this compares to the conceptual understanding demonstrated by students who follow traditional classes on similar subjects. However, in order to illustrate student learning in context-based learning environment King (2016) does report on how students in both of the presented cases managed to connect the presented context to scientific concepts.

In their group discussions during the first half of the course, the chemistry students who conducted their projects entirely inside the classroom managed to make fluid transitions between context and concepts, drawing conclusions about the health of the creek based on scientific concepts and laboratory results, and letting these conclusions inform further questions and tests (King, 2016). This was not observed in the second half of the course, when the teacher moved away from teaching in a student-centred and context-based manner.

The students who made weekly visits to their local creek made a stronger connection between context and concepts than the students who remained in their classroom. For the students who made weekly field trips, these two seemingly distinct elements of the curriculum merged as students applied scientific concepts in real time to the world they found themselves in (King, 2016). In addition, **though their weekly visits students came to see the creek as a valuable part of the local community, which in turn increased how important they perceived environmental management to be**.

## Highlighted: Teacher roles

The context-based learning approaches described in the previous section differ strongly on many accounts, but one of the things they have in common is the facilitating role which teachers play in the teaching approaches. Context-based learning is student-centred, which means that students play a significant role in deciding what they learn and how they learn it (Taconis, Den Brok, & Pilot, 2016). As a result, teachers play a less central role in context-based classes than they do in traditional classes. Instead of giving lectures, teachers provide support for student projects, and observe the progress of their students (Smith, 2002). While it might be challenging for experienced educators to take a step back and let students have such a strong influence in a class, Fechner and Sumfleth (2016) argue that it is limiting to the outcome of a context-based class when students are not given the freedom to choose their preferred problem situation or context, and instead learn with predefined settings.

For student-centred education to succeed, teachers need to create structures to aid student agency. However, giving students the freedom to influence the direction of a course can lead to unexpected turns, which in turn requires flexibility on the teacher’s part (King, 2016). Teachers also need to be flexible in the sense that, when discussions do not proceed as expected, they know when and how to adjust without impinging on student agency (Visser, 2017) (King, 2016).

There may be best practices when it comes to the role a teacher plays in context-based education, but the high demands which student-centred education places on teaching staff imply that the success of student-centred education depends greatly on the teacher’s enthusiasm and motivation for a project (Fechner & Sumfleth, 2016). Teacher preferences should, and will, therefore play an important role in the development of context-based education approaches for the USE learning line ‘Responsible Innovation in a Global Context’.

## Highlighted: Assessment methods

A key feature of the context-based learning approaches described in section 2.3 is that, in addition to attempting to cultivate conceptual knowledge, they aim to change the attitudes that students have about the specific topic. Where assessing conceptual understanding is relatively straightforward, assessing a change in attitudes is not.

For the assessment of conceptual understanding, having students write a report is the preferred method (Fechner & Sumfleth, 2016) (Smith, 2002) (Lee & Schottenfeld, 2012) (Vennix, Den Brok, & Taconis, 2017). This is likely due to the prevalence of project-based education in context-based learning. A big issue with assessing conceptual understanding within context-based learning is that it can be difficult for students to recognise and isolate scientific concepts within the contextual information provided (Fechner & Sumfleth, 2016). This issue surfaces especially when conceptual knowledge is presented in a contextualized manner during learning activities, but is assessed in a decontextualized manner. As a solution, teachers could consider making both the learning activities and the assessments contextualised.

As noted, the described teaching methods were not only designed for conceptual knowledge transfer, but also to change students’ attitudes; to cultivate more interest in chemistry; to increase engagement with the local community; or to instil an understanding of the importance of sustainability and a global perspective. An attitude change is much more difficult to assess than conceptual understanding. Three of the studies used self-reporting surveys to gather information about student attitudes as a result of context-based education (Lee & Schottenfeld, 2012) (Fechner & Sumfleth, 2016) (Vennix, Den Brok, & Taconis, 2017). The studies of the remaining teaching approaches provided purely anecdotal evidence of a change in student attitudes (Smith, 2002) (King, 2016) (Visser, 2017).

The prevalence of report-writing as an assessment method in context-based learning will be taken on board during the development of the USE learning line ‘Responsible Innovation in a Global Context’, as will the challenges of assessing decontextualized conceptual understanding and changes in attitudes.

## Conclusion

Although the approaches discussed are very diverse, there are various common elements among them. This final section highlights the relevant lessons which can serve as a springboard for the design of the context-based teaching methods for the USE learning line ‘Responsible Innovation in a Global Context’. These general lessons, drawn by structuring context-based learning approaches along the categories of the curricular spider web, are presented in Table 5.

Table 5: General lessons drawn from the discussed context-based learning approaches

|  |  |
| --- | --- |
| **Rationale**  Why are they learning? | Placing conceptual information in the right context can increase the perceived relevance of the conceptual information, and in turn lead to a better understanding of the concepts (Pilot & Bulte, 2006b). |
| **Aims and objectives**  Towards which goals are they learning? | The aim of context-based teaching approaches is often three-fold; 1) transferring conceptual knowledge relating to the course, 2) illustrating the importance of theory in practice, and 3) improving students’ attitudes about the field of study (Lee & Schottenfeld, 2012). |
| **Content**  What are they learning? | Content is largely course-dependent |
| **Learning activities**  How are they learning? | In general, learning activities are student-centred instead of teacher-centred (Taconis, Den Brok, & Pilot, 2016). This means that, within the scope of the course, students’ interests dictate the conceptual knowledge transfer between the teacher and the students. Student-centred learning activities often involve an exploratory project, which students carry out individually or in groups. Allowing students to explore a topic in order to cultivate their own insights can make these insights more robust (Visser, 2017) (Taconis, Den Brok, & Pilot, 2016).  The context in which learning activities are presented needs to be relevant for the course content, and salient to the students. It should therefore arise from prominent and contemporary social issues or from the students’ everyday lives (Pilot & Bulte, 2006a). However, if the context is meant to enable productive discussions about controversial subjects, it may be best to choose a real-adjacent context, and not a real context, as Visser (2017) shows.  The different cases show that lab work, fieldtrips, and games are specific learning activities which can be very useful to the integration of concepts and context. |
| **Teacher role**  How is the teacher facilitating their learning? | Context-based learning is student-centred, which means that teachers play a less central role than they do in traditional classes. Instead of giving lectures, teachers provide support for student projects, and observe the progress of their students (Fechner & Sumfleth, 2016). On the one hand, teachers need to be flexible enough to allow student agency. On the other hand, teachers need to know when and how to adjust to unwanted developments without impinging on student agency (Visser, 2017). |
| **Location**  Where are they learning? | Context-based education is usually provided entirely in the classroom or partly in the classroom and partly outside of the classroom. King (2016) shows that context-based education which takes place partly outside of the classroom is more effective in terms of letting students interact with and learn from the context. However, the success of context-based education depends greatly on the teacher’s enthusiasm and motivation for a project (Fechner & Sumfleth, 2016). Teacher preferences should therefore play a significant role when choosing the right location for context-based education. |
| **Assessment**  How is their learning assessed? | Assessing conceptual understanding is relatively straightforward, and can be done using a variety of traditional assessment methods. Having students write a report is the preferred method in the cases presented here (King, 2016) (Vennix, Den Brok, & Taconis, 2017).  Assessing a change in attitudes is more difficult, and is either based on a self-report study (Fechner & Sumfleth, 2016) (Lee & Schottenfeld, 2012) or on observations made by a teacher or researcher (Visser, 2017) (Smith, 2002). |

# Learning line ‘Responsible Innovation in a Global Context’

## Introduction

This chapter describes the broad set-up of the learning line ‘Responsible Innovation in a global context’, as well as the current ideas about the three courses which make up the learning line. As Fechner and Sumfleth (2016) explain, the enthusiasm and motivation with which educators take up context-based education projects is an important factor in their success. Therefore, the following set-up for the learning line ‘Responsible Innovation in a global context’ has been based on insights from the preceding literature review, but also on the personal educational experience and interests of the authors of this report, and brainstorm sessions with the other educators involved the development of the USE learning line.

This chapter is structured as follows. Section 3.2 lists the learning goals for the full learning line curriculum, as well as explaining what role the topic of Responsible Innovation plays in shaping these learning goals. Section 3.3 gives a brief overview of the rationale, approach and structure of the learning line, after which sections 3.4, 3.5, and 3.6 elaborate on the content, planning, and teaching and assessment methods of the individual courses quartile 1, 2, and 3 respectively.

## Learning goals

In the USE learning line ‘Responsible Innovation in a global context’ students will learn how to analyse and design responsible innovations that are tailored to global contexts. In doing so, they will be introduced to a set of concepts and approaches that they will use in the analysis and the design of technology interventions. Besides this, students will be exposed to diverse external stakeholders and learn about innovations for global markets in practice. Through these encounters students will also learn to communicate about (their) responsible innovations. By integrating global context with university education, the learning line ‘Responsible Innovation in a Global Context’ will help to prepare students for a potential career in an international setting.

The choice for the central topic of the learning line, Responsible Innovation, is motivated strongly by the personal interest of Johanna Höffken, the responsible lecturer for the learning line. Furthermore, Responsible Innovation is a topic which is not yet covered in the existing USE learning lines, and therefore an interesting addition to the Bachelor College curriculum at the Eindhoven University of Technology. Within the learning line, Responsible Innovation serves as the overarching framework which connects disciplinary and interdisciplinary knowledge and skills (Spelt, Biemans, Tobi, Luning, & Mulder, 2009). The central role which Responsible Innovation plays in determining both the content and the structure of the learning line is illustrated in the learning goals. As Lee and Schottenfeld (2012) suggest, the learning goals for this context-based curriculum are broadly three-fold: 1) Transferring conceptual knowledge about Responsible Innovation; 2) Illustrating the importance of Responsible Innovation in practice, and; 3) Improving students’ attitudes about Responsible Innovation.

Specifically, the learning goals are the following:

* Students understand the relevance of Responsible Innovation for and in the global context.
* Students can draw on a theoretical concept- and tool-kit for analyzing and designing responsible innovations.
* Students apply these tool kits and engage in the design of a responsible innovation-idea.
* Students can meaningfully reflect on their analyses and designs.
* Students get an informed insight into how innovations for the global context work in practice.
* Students can communicate their ideas about responsible innovation in a global context to a diverse set of stakeholders.

## Rationale, structure, quartile themes, and “teaching treat”

Innovations are only successful if they incorporate a deep understanding of and respond adequately to the social, political and environmental contexts in which they are to thrive. Starting and engaging with the context ensures that innovations are both impactful and responsible. This context-response-ability is thus a sine-qua-non condition for the development of innovations that aim to make a meaningful difference in people’s lives, both in the global north and south.

Based on this premise, this learning line both cradles and responds to an increasing interest by students wanting to explore how their ideas could make an impact on people’s lives outside the familiar northern world context. The course will offer students the possibility to professionalize this interest by theoretically and practically introducing them to the development of responsible innovations in and for global contexts. By explicitly opening up the global dimension and connecting it to responsible innovations in practice, the learning line provides an essential addition to the range of topics and scopes of the existing USE courses.

As of now, the Learning Line Responsible Innovation (RI) in a global context is a collaboration between IE&IS and Electrical Engineering. It is set up to start in September 2018 and is designed to run as a pilot. The maximum number of students of the 2018/19 pilot is therefore set to 30 students.

The course draws on a broad definition of innovation, in which innovations are conceptualized as having a socio-economic effect and changing the way people live.[[5]](#footnote-5) With this, the Learning Line’s emphasis is less on the technical radicality or novelty, but the course sequence has a clear focus on the contextual factors that shape and are being shaped by innovations.

Students are challenged to come up with innovative interventions that are aimed at tackling issues people face in the global South. In the first pilot run, such interventions are likely to be only within the field of energy, but it is the clear ambition of the Learning Line to expand the scope, as to not limit students’ creativity and field of application.

Each quartile has its own theme, which sets the tone for the unfolding work and activities. Besides this, each quartile is endowed with a “teaching treat”. This is an innovative or unconventional teaching method, approach, or student assignment, aimed to inspire students and teachers alike.

## Q1: Let’s go RI!

#### Theme: “feel and touch” or topic immersion

The Q1-course is about providing a “feel and touch” or topic immersion to make the relevance of Responsible Innovation in a global context clear. [[6]](#footnote-6) Over the weeks there is a smooth shift from emphasizing “feel and touch”/topic immersion to emphasizing conceptual tools (to better understand this “feel and touch”).

#### Teaching treat: Design for Failure

Students will work individually on a portfolio about a Responsible Innovation idea. This portfolio is set up in such a way that they have to make sure their detailed elaborations end up as a failure (instead of success). Visser (2017) states that allowing students to explore a topic and come to conclusions on their own can make these conclusions more robust. This suggests that asking students to design for failure, and therefore requiring them to engage with questions about how innovations may fail by overlooking certain issues, can make their insights about the importance of Responsible Innovation more robust than when these insights are ‘given’ to them.

The Responsible Innovation ideas need to have a link to electrical power systems.

#### Preliminary Planning

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Week 1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** |
| 1st moment | Intro | Innovations for the global context(II) | Failed innovations  (disregarding gender; context) | Responsible Innovations | Colonialism | Markets & development (emerging markets, (neo-liberalism) | Methods, design approaches and the role of participation | Presentation DFF |
| 2nd moment | Innovations for the global context (I) | Intro-lecture: electrical power systems | Intro-lecture Renewables | Movie: “Framing the other" | Interactive tutorial (relating to theme colonialism) | Interactive tutorial (relating to markets theme) | Guest lecture | Presentation DFF |
| individual student work |  | Start Design for Failure (**DFF**) Portfolio | DFF | DFF | DFF; mid-quartile assessment of DFF | DFF | DFF | DFF;  students form groups for Q2 |

#### Learning goals Q1

* Students understand the relevance of Responsible Innovation for and in the global context.
* Students can draw on a theoretical concept- and tool-kit for analyzing and designing responsible innovations.
* Students apply these tool kits and engage in the (unsuccessful) design of a responsible innovation-idea.

#### Teaching method mix

Q1 will broadly follow the idea of lectures during the first contact moments in the week and tutorials during the 2nd contact moment. Generally, tutorials take various forms but share the same goal: to further explore and apply aspects and dimensions of the issue discussed in the previous lecture in a more interactive, thought- and discussion-provoking way.

#### Teaching material

* A template of the Design for Failure portfolio will be developed, which will be filled by the insights and work of each student.
* Selected scientific articles will be combined into a reader for Q1.

#### Assessment Q1

* In Q1 students will be assessed on the basis of their individual Design for Failure (DFF) portfolio.
* The mid-term assessment will evaluate the state of quality of the DFF in week 4 or 5.
* Both the DFF-mid-term grade and the DFF-final grade will determine the student’s overall grade for Q1.

This type of assessment, based on both the final portfolio and its progression, contains both development and performance components, as suggested by Spelt et al. (2009).

## Q2: Let’s design!

#### Theme: Design it in the Innovation Space

During Q2 students will design their own RI idea in the Innovation Space. They have gotten to know each other better during the first quartile and will have formed groups by the end of Q1. They can draw on a pool of RI ideas, as each student had to theoretically develop one idea during Q1.

#### Teaching treat: Teaching on Demand

Though there will be fixed plenum meetings during this quartile, students are asked to formulate which technical knowledge[[7]](#footnote-7) and USE-related knowledge they need for designing their idea (“Teaching on Demand”). Teachers will support and accompany this question finding. In their work students will have to take into consideration the insights they gained from the DFF portfolio, yet this time in its success version.

As suggested by several publications about context-based education, this set-up is strongly student-centred. This means that student interests are leading in the development of course content (Smith, 2002) (Taconis, Den Brok, & Pilot, 2016). This student-centred approach increases the perceived relevance of the transferred knowledge, while the teacher-supported question finding process allows the teaching staff to somewhat moderate the demands of the students to ensure it remains feasible to teach on demand.

#### Preliminary Planning

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Week 1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** |
| 1st moment | Intro (EE&IS) |  | Teaching on demand (IS) |  | Teaching on demand(IS) |  | Teaching on demand (IS) | Demonstration |
| 2nd moment | Project proposal and approval | Teaching on demand (EE) |  | Teaching on demand (EE) |  | Teaching on demand (EE) |  | Demonstration |

#### Learning goals

* Students can draw on a theoretical concept- and tool-kit for analyzing and designing responsible innovations.
* Students apply these tool kits and engage in the design of a responsible innovation-idea.
* Students can meaningfully reflect on their analyses and designs.

#### Teaching method

Q2 follows the format of an OGO (design oriented education). Q2 is set up in such a way that students will have regular supervision and feedback from teachers. Students and teachers set the agenda for these supervision and feedback moments (teaching on demand). This method focuses strongly on the application of knowledge, rather than the memorization of facts. This, in combination with the ill-structured, self-devised projects which the students will be working on, stimulates the development of skills for coping with ambiguity (Spelt, Biemans, Tobi, Luning, & Mulder, 2009) (Ba-Aoum, 2016).

#### Teaching material

* Online environment (Canvas) for gathering questions and for communication.
* Simulation software (technical part).
* Template for final report (technical and RI-related.

#### Group work product

In the design of a RI idea they will have to be specific about the location where their idea is to be implemented. They will have to engage in specific/tailor-made data collection. This will be needed for making a meaningful simulation (technical part) and considering relevant RI related aspects.

#### Assessment Q2

In Q2 students will be assessed on the basis of their RI design. Their results will be synthesized in a report. This report will be evaluated on the quality of their technical and RI –related findings/work.

## Q3: Let’s connect!

#### Theme: RI out there

This quartile is about “touching the world” and getting outside of the university context. Students will get in touch with diverse stakeholders working in the field of Responsible Innovation in a global context. Partnering with these external stakeholders can help to further strengthen students’ appreciation for the uncertainty and ambiguity which they will encounter in the real world (Spelt, Biemans, Tobi, Luning, & Mulder, 2009).

#### Teaching treat: connect and get connected

The quartile will involve different stakeholders, from the public and private sector. The aim is to provide students some insights into how RI works in practice. Through this, students will also get the opportunity to communicate with professionals and reflect on their own RI work. This interaction will be facilitated through both guest lectures and site visits, because taking education outside the classroom can increase the effectiveness with which students interact with and learn from contexts (King, 2016).

#### Learning goals

* Students can meaningfully reflect on their analyses and designs.
* Students get an informed insight into how innovations for the global context work in practice.
* Students can communicate their ideas about responsible innovation in a global context to a diverse set of stakeholders.

#### Range of external partners

Contacts have been established with a range of stakeholders who have indicated interest in contributing to the Learning line. These include Rural Spark, PRE-Power Research Electronics, Philips Lighting, Philips Healthcare.

#### Assessment Q3

Students will be evaluated on their individual context portfolios. They either use their individual idea (Q1) or their group idea (Q2) and relate it to insights provided during each guest lecture/site visit.

The mid-term assessment is organized in such a way that students can demand on which topic they want to be assessed and in which of the 3 time slots (week 5, 6 or 7).

# Envisioned Learning Line Spin-offs

* TU/e broad expertise

In Q2 knowledge from diverse faculties could be consulted “on demand”, broadening the range of innovations that are being designed in the Innovation Space.

* RI platform for teaching and research

By connecting the university with external stakeholders, engaged in RI-work for the global context, the learning line has the potential to become a platform for teaching and research on RI for the global context (inspired by MIT’s D-Lab).

* Field trips

Motivated students could be engaged in field trips to get an even more direct insight into RI for the global context.

* Spin-offs

The LL might produce responsible innovations with practical (market) relevance. Promising student-ideas might be further (commercially) developed by student teams even after the LL has ended.

# Works Cited

Ba-Aoum, M. (2016). Comprehensive Model for Fostering Humanitarian Engineering Education. *IEEE 2016 Global Humanitarian Technology Conference*, (pp. 304-311). Seattle.

Barile, S., Saviano, M., & Simone, C. (2015). Service economy, knowledge, and the need for T-shaped innovators. *World Wide Web, 18*, 1177-1197.

Billett, S. (2009). Realising the educational worth of integrating work experiences in higher education. *Studies in Higher Education*, 827-843.

Fechner, S., & Sumfleth, E. (2016). Science kits - Learning chemistry in a context-oriented learning environment. In R. Taconis, P. Den Brok, & A. Pilot (Eds.), *Teachers creating context-based learning environments in science* (pp. 59-70). Rotterdam, The Netherlands: Sense Publishers.

Guajardo, F. (2015, November 2). *Border Stories | Francisco Guajardo | TEDxMcAllen.* Retrieved from www.youtube.com: https://www.youtube.com/watch?v=kO-1xqyec-Y

Hu, L. (2017, July 1). *Terra Nova Minimaatschappij*. Retrieved from lisahu.nl: http://www.lisahu.nl/#/terra-nova/

King, D. (2016). Teaching and learning in context-based science classes. In R. Taconis, P. Den Brok, & A. Pilot (Eds.), *Teachers creating context-based learning environments in science* (pp. 71-85). Rotterdam, The Netherlands: Sense Publishers.

Lee, Y., & Schottenfeld, M. (2012). Internationalising Experiential Learning for Sustainable Development Education. *Pedagogical Interventions for ESD, 6*(2), 341-354.

Llano Grande Center. (2017). *Llano Grande Center history and mission*. Retrieved July 28, 2017, from www.llanogrande.org: http://www.llanogrande.org/about-us/

Meijers, A., & Bombaerts, G. (2016, November 22). USE onderwijs aan de TU/e.

Pilot, A., & Bulte, A. (2006). The Use of "Contexts" and a Challenge for the Chemistry Curriculum: Its successes and the need for further development and understanding. *International Journal of Science Education, 28*(9), 1087-1112.

Pilot, A., & Bulte, A. (2006). Why Do You "Need to Know"? Context-based education. *International Journal of Science Education, 28*(9), 953-956.

Smith, G. A. (2002). Place-based Education - Learing to Be Where We Are. *Phi Delta Kappan, 83*(8), 584-594.

Spelt, E., Biemans, H., Tobi, H., Luning, P., & Mulder, M. (2009). Teaching and Learning in Interdisciplinary Higher Education: A Review. *Educational Psychology Review*, 365-378.

Subrahmanian, E., Westerberg, A., Talukdar, S., Garrett, J., Jacobson, A., Paredis, C., . . . Turk, A. (2003). Integrating social aspects and group work aspects in engineering design education. *International Journal of Engineering Education*, 75-80.

Taconis, R., Den Brok, P., & Pilot, A. (2016). Introduction. In R. Taconis, P. Den Brok, & A. Pilot (Eds.), *Teachers creating context-based learning environments in science* (pp. 1-17). Rotterdam, The Netherlands: Sense Publishers.

TU/e. (2017, August 28). *USE Learning Trajectory*. Retrieved from educationguide.tue.nl: https://educationguide.tue.nl/programs/bachelor-college/use-learning-trajectory/

Van den Akker, J. (2003). Curriculum perspectives: An introduction. In J. Van den Akker, W. Kuiper, & U. Hameyer (Eds.), *Curriculum landscapes and trends* (pp. 1-10). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Vennix, J., Den Brok, P., & Taconis, R. (2017). Perceptions of STEM-based outreach learning activities in secondary education. *Learning Environments Research, 20*, 21-46.

Visser, J. (2017, July 11). *Zo kan het onderwijs kinderen wél tot kritische burgers opleiden*. Retrieved July 13, 2017, from decorrespondent.nl: https://decorrespondent.nl/7046/zo-kan-het-onderwijs-kinderen-wel-tot-kritische-burgers-opleiden/870113823436-9a4ebe59

White, L. (2005). Making Sense of Adult Learning: Experiential Learning. *New Horizons in Adult Education and Human Resource Development, 19*(4), 31-41.

1. USE curriculum goals: 1) Clear notion of USE in relation to technology, 2) Knowledge of concepts, tools, and methods in the humanities, 4) Able to take a well-argued stance on USE, 5) Able to reflect on the engineering profession, and 8) Motivated to take USE aspects into account when developing technology. [↑](#footnote-ref-1)
2. USE curriculum goals: 1) Clear notion of USE in relation to technology, 2) Knowledge of concepts, tools, and methods in the humanities, 3) Apply knowledge in the design, development and evaluation of technologies, and 8) Motivated to take USE aspects into account when developing technology. [↑](#footnote-ref-2)
3. USE curriculum goals: 4) Able to take a well-argued stance on USE, 5) Able to reflect on the engineering profession, 6) Able to work in multidisciplinary teams, 7) Able to communicate to societal stakeholders, and 8) Motivated to take USE aspects into account when developing technology. [↑](#footnote-ref-3)
4. USE curriculum goals: 1) Clear notion of USE in relation to technology, and 8) Motivated to take USE aspects into account when developing technology. [↑](#footnote-ref-4)
5. Definition by Wiebe Bijker [https://ec.europa.eu/epsc/publications/strategic-notes/opportunity-now-europe’s-mission-innovate\_en#h-1-1](https://ec.europa.eu/epsc/publications/strategic-notes/opportunity-now-europe's-mission-innovate_en#h-1-1) [↑](#footnote-ref-5)
6. Great attention will be paid to avoid anything which supports ideas about “the exotic other” or which feeds cultural voyeurism/arrogance/colonialism. [↑](#footnote-ref-6)
7. Related to electrical power systems [↑](#footnote-ref-7)