Work package

Field labs: Evidence-informed innovation of education & Effectiveness of educational innovation

Part 2 of 2: Preparation module



Acceleration plan
Educational innovation with ICT

evidence-informed

Field labs work package: Evidence-informed innovation of education & Effectiveness of educational innovation

Part 2 of 2: Preparation module

Acceleration Plan for Educational Innovation with IT
Evidence-informed innovation of education with IT zone &
Digital education of practical skills working group

Acceleration plan
Educational innovation
with ICT

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These field labs are based on the University of Twente's Senior University Teaching Qualification (SUTQ) trajectory and the University of Warwick model (Brown, 2020).

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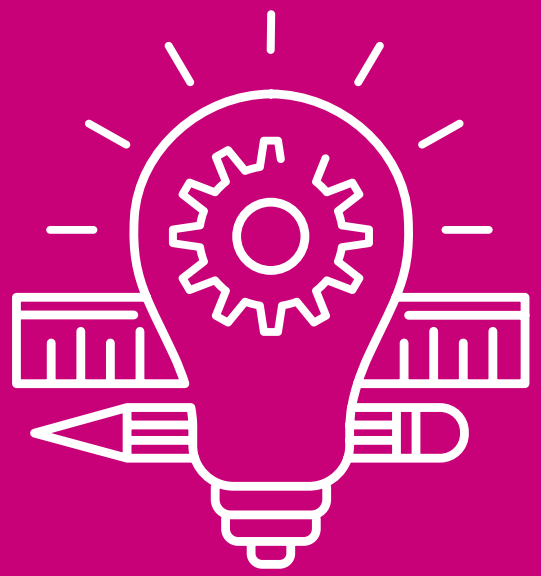
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Introduction

This preparation module contains basic information for facilitators of and participants in the *Evidence-informed innovation of education* and *Effectiveness of educational innovation* Field labs. It includes a theoretical framework and modelling examples, in the form of six interviews with colleagues in higher education who have recently implemented educational innovation in educational practice.

We recommend that both facilitators and participants take the time to read through the theoretical framework, but the interviews, which present examples of innovation in higher education, may be studied as required. The themes covered in the interviews are described in the summary on the first page of the modelling examples, under *Introduction and methodology*.

Theoretical framework

Evidence-informed innovation of education with IT

What do we mean by evidence-informed innovation and what does it entail?

Jerich Faddar & Elske van den Boom-Muilenburg

Preface

This theoretical framework contains background information on the *Evidence-informed innovation of education* field lab and provides lecturers, education support staff and other stakeholders with the concepts and knowledge they need to prepare and implement the Field labs. Following the introduction, we delve into the concept of 'evidence-informed innovation', after which we present a method for its implementation in the field lab.

Introduction

Innovation has a large role to play in meeting the challenges faced by higher education, such as how to improve and accelerate the use of IT. Unfortunately, however, educational innovations often turn out to be difficult to implement, or even end in failure. One reason for this is that the education professionals who develop these innovations do not make enough use of the information, or evidence, already available. In the *Evidence-informed innovation of education* field lab, we consider the best way to select and use different forms of evidence to achieve successful innovation. As we will see, a combination of experiential knowledge, knowledge generated from research and information on the organisation in which the innovation will be implemented can strengthen an innovation initiative and considerably increase its chance of success.

The aim of the field lab is to bring together education professionals in a setting in which they are exposed to these insights and in which they can experiment with them. The idea is that they can then take what they have learned back to their own higher education institution, professional development team or workplace. The theoretical background presented here is not intended as a comprehensive overview of the academic literature, but to provide conceptual frameworks to support the approach taken in the Field labs and foster and enhance ideas on evidence-informed innovation. Note that, although this field lab concerns innovation in education with IT, this theoretical framework also applies to innovation in education in general.

The field lab is concerned not only with designing the most well-founded and successful innovation process possible, but also with assessing the effectiveness of the innovation. After all, identifying the outcomes of the innovation and what can be learned from the innovation process provides important lessons for the future: for other contexts and other innovations. Concepts and models are provided for this in the theoretical framework: *Effectiveness of educational innovations*.

Introduction to evidence-informed innovation

Innovation is learning

Higher education is faced with several challenges, such as a demand for more flexible education, digitalisation, a growing gap between high- and low-performing students and increased student diversity. Education institutions are expected to come up with answers to these challenges, to adequately prepare each student for their place in society (Vanlommel, 2021; VSNU, VH & SURF, 2017). This requires that education institutions, and in particular the education professionals who work in them, respond in a fitting manner to these challenges, which are taking place in rapidly changing contexts. One way in which they can do this is by implementing change, or innovation, in their educational practice. The terms 'change' and 'innovation' are often used interchangeably, but in change management a clear distinction is made between them, and this is certainly relevant in the context of the *Acceleration Plan Educational Innovation with IT*, where the focus is on innovation.

The **difference between change and innovation** relates to the extent to which learning takes place or, more specifically, the extent to which and the way in which learning takes place in the organisation (Argyris, 1976; Argyris & Schön, 1996; Boonstra, 2000; Ruijters & Simons, 2006). This is shown clearly in the figure below.

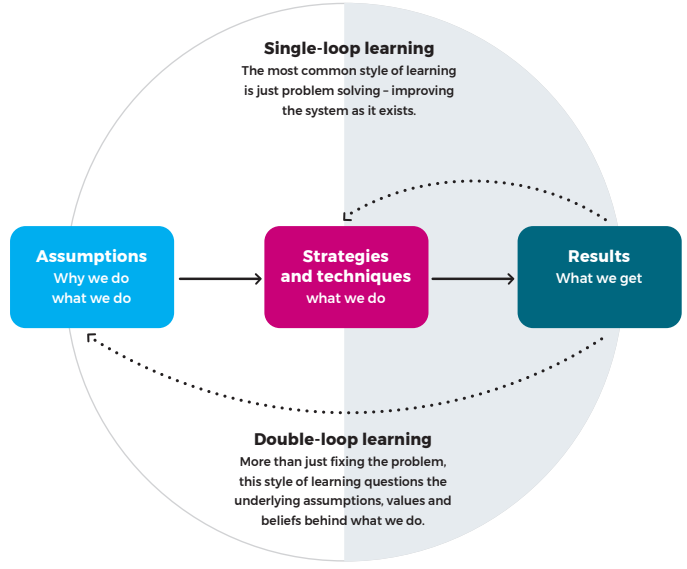


Figure 1 Single-loop and double-loop learning (based on Argyris & Schön, 1996)

When designing and delivering education, education professionals work with a certain set of assumptions, based on which they implement strategies or techniques in educational practice. This educational practice could be an activity such as a lecture, a practical demonstration, a test, a practical session, an internship, and so on. These educational activities lead to certain results, which are often expressed as the acquired competencies of the learners.

When educational change or innovation takes place, this pattern is broken, as the results – such as the competencies of students at graduation – can lead to questions being asked about the completed educational activities (e.g. if a misalignment is detected between the competencies acquired and the requirements of the professional field). If the question concerns how these strategies or techniques can be improved, this is **single-loop learning**, which focuses on making changes to an existing system and improving the results, or outcomes. If the focus is not just on improving existing educational activities but on considering – or reconsidering – the underlying assumptions, then this is **double-loop learning**. This therefore goes beyond finding a quick fix and is more fundamental in nature, as it requires critical consideration of the reasoning behind the educational activities. This, therefore, is educational innovation, which can be implemented either to change current educational practice or to develop new educational practices.

In the hectic day-to-day of educational practice, people may not take the time needed to apply double-loop learning; rather, they may attempt to find solutions by making small changes. However, this often fails to achieve the required results, as it is only through double-loop learning that innovative change can be implemented in existing practice.

The Acceleration Plan focuses on the implementation of IT in education. While digitalisation has been a hot topic in education for some time, it became even more relevant during the COVID-19 pandemic, when developments really started to take off. Education is increasingly being integrated – sometimes extensively – with IT, often to provide an alternative to face-to-face contact. This can be achieved without too much trouble for a lecture, but is more challenging for other educational forms, such as teaching practical skills. How can we teach students to weld a joint using IT, or reanimate a patient? The current context is forcing education professionals to consider the possibilities and limitations of integrating IT into education, and possible applications. Innovations are therefore needed in education that make use of IT, which requires critically examining the underlying assumptions and, based on this, reconsidering the education design.

Evidence-informed innovation

The social-constructivist approach to learning asserts that learning does not take place in a vacuum (Valcke, 2021). This means that, in innovation processes, the context and interaction with others should be used by education professionals to evaluate assumptions and reconsider the education design. Different types of evidence can be used to do this.

As professionals in their field, lecturers have a great deal of autonomy to design their own teaching, which is based on their constructed assumptions; assumptions that form part of the lecturer's **experiential knowledge**. A lecturer's experiential knowledge is defined as the knowledge and competences that are acquired through their experiences in their work and that are required to be successful in their work (Smith, 2005). It is an important source of knowledge; in other words, a source of evidence that education professionals can use to shape innovation processes. After all, it is based on their experiential knowledge that education professionals are able to quickly recognise and therefore respond to signals. However, innovation based on experiential knowledge alone does not always have the desired effects. In fact, research shows that it leads to a focus op quick, practical solutions, but not to real innovation and the solution of the identified problems (Schildkamp & Kuiper, 2010). There is also a risk of confirmation bias, which is the tendency that people have to only use information that confirms their own assumptions (Kahneman & Frederick, 2005). This can result for example in incorrect opinions and stereotyping (Brookhart, 2003; Feinberg & Shapiro, 2009; Harlen & Deakin, 2002), and the accuracy of experiential knowledge cannot therefore be guaranteed.

The use of other types of evidence is therefore recommended and, in the case of educational innovation, could include **school, organisation and system information**, which is information that can be systematically collected and organised to describe certain aspects of the education institution (Mandinach & Schildkamp, 2021; Vanlommel, Van Gasse, Vanhoof & Van Petegem, 2020). Examples are exam results, lesson observations and student feedback. This type of information can provide insight into the results achieved and the current situation in the education institution, and can therefore help to identify the needs of students and policy blind spots.

Another type of evidence is **knowledge generated from research**, which is the knowledge obtained from formal research (Cain, 2015). This kind of information can be obtained from academic articles, conference presentations and researchers' contributions to academic journals. Knowledge generated from research provides validated and reliable information on what does and what does not work in educational innovation (Brown & Zhang, 2016).

However, innovation based on school, organisation and system information and/or knowledge generated from research alone is not enough, as an understanding of the wider context is required for the meaningful interpretation of the data (Brown et al., 2017). Simply using school, organisation and system information or knowledge generated from research can therefore also result in the previously mentioned confirmation bias, especially if such information is gathered spontaneously (Harteis et al., 2008; Kahneman & Frederick, 2005). Without a predefined plan or goal for data collection, education professionals might only see the data that confirms their ideas. For example, a lecturer may think that a certain student lacks motivation, and if the student is often absent they will interpret this data (system information) as confirmation of this. The reality, however, may be that the student is absent for personal reasons and asks other students for their lectures notes to catch up on what they have missed. A clear, rational and methodical approach is therefore required.

Innovation based on one type of evidence therefore has its limitations, regardless of the type of evidence that is used. **Combining and integrating different types of evidence** in the innovation process makes it possible to consider and contrast information from different sources ('triangulation'). This tests the personal assumptions or frame of reference of the education professional (Earl & Katz, 2006; Kahneman & Klein, 2009). The education professional's experiential knowledge is important for identifying which data and research-generated knowledge is relevant in a particular context and for converting data into useful information (Vanlommel & Schildkamp, 2019; Vanlommel, 2021). The information obtained in this manner can be considered to be reliable, and this process is called evidence-informed innovation. While there is some discussion regarding the definition of the concept 'evidence-

informed', we define it in the field lab as: **well-founded innovation that is informed by a combination of experiential knowledge, school, organisation and system information and knowledge generated from research** (Brown et al., 2017; Malin et al., 2020; Vanlommel, 2021). A variety of sources is therefore necessary and valuable when initiating, implementing and evaluating innovation processes in education (Vanlommel, 2018).

Evidence-informed innovation in the Field labs

Although evidence-informed innovation has been implemented in other sectors for some time (e.g. in management practice (Ten Have & Ten Have, 2016) and the medical sector (Fryer, 2011)), it is relatively new in education. Evidence-informed education systems are being developed in the UK (Coldwell et al., 2017) and in the US (the Every Student Succeeds Act (2015)) but, in the Netherlands, evidence-informed innovation has not yet been implemented at a large scale. However, the report *Omwille van Goed Onderwijs* [*For the sake of good education*] (2021) recently noted "*the limited extent to which an evidence-informed approach is taken to development, quality improvement and innovation in education in the Dutch education system*." (p.3). It is time to change this!

Collective learning

For the successful implementation of evidence-informed innovation in educational practice, the increased awareness and professional development of education professionals is required in the following areas:

- learning to recognise and acknowledge personal experiential knowledge and confirmation bias;
- applying a clear and rational approach to data collection;
- acquiring the necessary skills for the analytical comparison and assessment of different information sources.

Education professionals are traditionally considered to work individually and autonomously (Hargreaves, 1994), and the 'in-service' learning of education professionals has therefore often focused on activities such as participation in external workshops and lectures and activities that encourage reflection (Hargreaves, 2019; Van Veen et al., 2010). However, the focus is increasingly shifting from individual to collective learning (Hargreaves et al., 2018; Vangrieken & Kyndt, 2020), as research shows that collaborative learning can greatly benefit the professional development of education professionals (Cordingley, 2015; Opfer & Pedder, 2011; Vangrieken et al., 2015). Collective learning can be described as learning in which education professionals work together to activate their ideas and professional knowledge, to critically inform their educational practice and to ensure that they stay up to date (Kools & Stoll, 2016). These interactions between education professionals are essential, and can be viewed as an organisational mechanism that produces new ideas, critical feedback and insight into multiple and different perspectives (Garavan & Carbery, 2012; Lee & Louis, 2019). In collaborative learning, education professionals can discuss educational practice and student learning, in depth and within their own context (Opfer & Pedder, 2011). Through such interaction, education professionals inspire each other, help each other by exchanging experiences and feedback or work together to develop innovative products (Meirink et al., 2007; Thurlings & Den Brok, 2017).

Collective learning and interaction between participants are also essential in evidence-informed innovation. First, the challenges in higher education are too complex to be dealt with by individuals alone (Stoll, 2010). The answer is therefore not to try to find ways to work "*harder alone*", but "*smarter together*" (Brown & Flood, 2020, p.5). Second, by only focusing on the evidence available to them as an individual, education professionals suffer from tunnel vision or the previously mentioned confirmation bias. Imagine, for example, that four people each contribute their own data, which may or may not be 'contaminated' with confirmation bias. Even just comparing the data from these four different sources will reduce the bias. As described above, combining different types of evidence can help people to reconsider their ideas or frame of reference, and doing this together with other people increases the chances of this happening. Therefore, combining the different types of evidence to which individuals have access makes it possible to compare different frames of reference, and therefore to initiate, implement and evaluate well-founded innovation processes in education.

Simply taking the time to work together on innovation as education professionals is however not enough (Hargreaves, 2019; De Jong et al, 2022). It is also important to delineate the innovation process. This is achieved in the field lab by designing the innovation process as a professional development activity and by taking a systematic approach.

Professional development in evidence-informed innovation

A field lab can be viewed as a set of experimental professional development activities or steps in which education professionals work both on their professional development and educational innovation. It therefore has features of the proven methods of a professional learning community (Stoll et al., 2006), of a learning community (Schipper et al., 2022) and of a network for learning (Brown & Poortman, 2018). After all, core elements of the field lab are also a **shared focus** and a reflective professional dialogue. A shared focus here concerns the collective objectives that the participants aim to achieve through their collaboration (Brown & Poortman, 2018), which in this case is the field lab. This helps to guide their work and collaboration, so that they can together generate new ideas, and so that they are

forced to consider their own education ideals (Lawrence & Chong, 2010). The field lab also helps education professionals to connect with one another, so that they can together think about how they will achieve the objectives (Senge, 1990). In a **reflective professional dialogue**, education professionals together consider the most urgent challenges and problems in their day-to-day educational practice and try to resolve them. In the process, collaborative ideas are generated and tested to improve educational practice (Brown et al., 2020).

As well as encouraging collective learning among education professionals, a field lab can be even more beneficial if it brings together education professionals with different profiles and backgrounds. Working with a **heterogeneous group of participants**, rather than an existing team of education professionals, increases participants' access to different types of information (Kezar, 2014; Moody & White, 2003). This therefore increases the diversity of the evidence and reduces the risk of confirmation bias.

Research shows that bringing together education professionals in this way can contribute to their learning (Dogan & Adams, 2018; Koopman et al., 2019), the extent to which they are open to change (Dogan & Adams, 2018; Hargreaves, 2019) and the extent to which they are willing and able to innovate (Bessant et al., 2012; Liu et al., 2022). The field lab is therefore a suitable activity for the professional development of education professionals in evidence-informed innovation. In this field lab, education professionals with different profiles and backgrounds work together, then return to implement the structured approach that they have learned in their own educational practice. This is organised in a systematic and cyclical process.

Cyclical, systematic approach to evidence-informed innovation

The importance of data in decision making and education design and redesign has been recognised for some time in education research (Brown & Zhang, 2016; Vanlommel, 2018). Various strategies are applied, such as assessment strategies and improvement strategies (Campbell & Levin, 2009; Swanborn, 2012). However, different – successful – change plans have one common denominator: they follow a cyclical, systematic and investigative approach (e.g. Felten, 2013; McKenny & Reeves, 2012; Schildkamp et al., 2014; Vanhoof & Van Petegem, 2022). The field lab was therefore developed based on such an approach, which in this case consists of a cycle of eight steps:

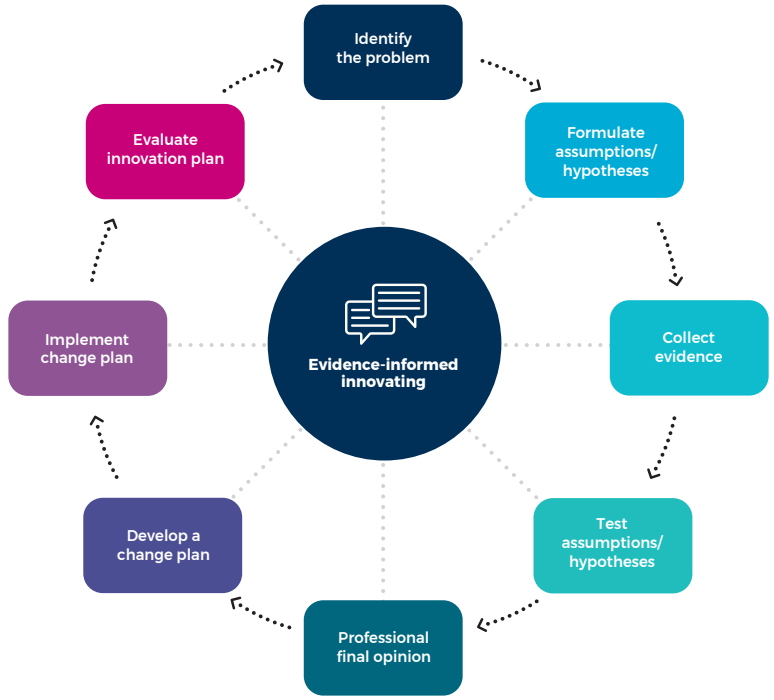


Figure 2 Cyclical approach in the 'Evidence-informed innovation of education' field lab in eight steps. This allows field lab participants to go back a step in the innovation process if necessary for fine-tuning or clarification before continuing.

Identify the problem. Participants identify the problem/issue/area for improvement that they wish to address in the field lab and the underlying sub-questions (thereby creating an investigative working method).

Formulate assumptions/hypotheses. Participants formulate explanations, assumptions and hypotheses that may underlie the identified problem.

Collect evidence. Participants jointly consider what evidence (experiential knowledge/ school, organisation and system information/knowledge generated from research) they consider necessary and relevant to this issue.

Test assumptions/hypotheses. Participants test their assumptions or hypotheses against the evidence.

Professional final opinion. Participants formulate a professional final opinion based on the evidence: confirmation or refutation of the assumptions/hypotheses.

Develop a change plan. Participants translate their insights into an innovation plan, aligning it with the characteristics of the context/institution. Subsequently, they set about designing or changing their educational practice.

Implement change plan. Participants implement the innovation plan in practice: they design and innovate their educational practice to address the identified problem.

Evaluate innovation plan. Participants evaluate the innovation process and whether the identified problem has been addressed. To do this, they may use the steps and theoretical framework described in the Effectiveness of educational innovation field lab. They also reflect on ways to share experiences (about misses and successes), the knowledge sources and the role that research has played.

The approach taken in the field lab is based on eight distinct steps, which the professionals are encouraged to take, one at a time. This ensures that participants do not draw hasty conclusions and implement actions without having properly thought them through (Brown, 2019; Schildkamp & Kuiper, 2010). The eight steps are part of a **cyclical, systematic process**. The cyclical nature of this approach refers to the fact that each step follows on from the previous step (see Figure 2). While theoretically the steps seem to be distinct from each other, and to progress from one to the next, this is not necessary in practice. Participants can go back to a previous step for fine-tuning or clarification at any point, and therefore do not always have to follow the same, or even a linear, route. Furthermore, the cyclical nature emphasises that there is no end point. As we know from the PDCA cycle, evidence-informed innovation is a continuous process whereby an evaluation can also form the start of a new cycle. The systematic aspect of the approach is reflected in the fact that the process must be carried out in full. The participant therefore needs to think about the approach to take and develop a vision to be able to implement the method, and to make sure to consider every step. After all, this is where the strength of the approach lies: in the fact that explicit attention is paid to each step in the process.

Making use of social capital

It is very important that, in the final step 'Evaluate innovation plan', participants share their results and experiences with their colleagues. Designing and implementing innovation on a small scale is one thing but, for successful, sustainable innovation, routines need to change (Wolthuis et al., 2021). These routines are part of the larger organisation, and they therefore concern everyone who is affected by the innovation. All of these people therefore need to be involved in the innovation. The social relationships between colleagues are important when organising change (Daly, 2010). As Margaret Wheatley, a well-known American management consultant, said: "In organizations, real power and energy is generated through relationships. The patterns of relationships and the capacities to form them are more important than tasks, functions, roles, and positions." She is referring here to **social capital**. Social capital is the system of social relationships through which people obtain access to the resources of others – such as knowledge and advice – which can be used for personal benefit or the benefit of the organisation (Lin, 2009).

Sharing the results and experiences makes use of and increases social capital, to ensure that the innovation reaches as many colleagues as possible. This therefore means exchanging and communicating the knowledge resulting from the field lab (Farley-Ripple et al., 2017). Colleagues who did not take part in the field lab must be made aware of the research and its results (Gaikhort et al., 2017) and encouraged to critically reflect on their own educational practice and implement changes where necessary (Brown et al., 2020). This achieves organisational learning (Argyris & Schön, 1996). This therefore means not only sharing information about the innovation itself (what is being innovated exactly and how do routines need to change?), but also about the innovation process (why were certain choices made, which decisions and evidence are they based on, and what does and does not work?) (Daly, 2010; Van den Boom-Muilenburg et al., 2022).

A popular method for involving colleagues in innovation is to share the results and experiences in a newsletter. However, although this makes it possible to reach a lot of colleagues quickly, there is a risk that they will not read the information. Other methods, such as organising a workshop or an interactive presentation in the form of a lunch lecture (Farley-Ripple & Grajeda, 2020; Van den Boom-Muilenburg et al., 2022; Ward et al., 2009), can be more successful. Designing activities to involve colleagues in the innovation process is also a good way of obtaining their constructive contribution. For example, they could be asked for their input and their wishes and needs. This makes sure that the innovation is aligned with the different needs of different people in the organisation. It also ensures that everyone who is affected is encouraged to be involved in the innovation early on in the process and to adapt their routines if necessary.

Effectiveness of educational innovation

Evidence-informed innovation is not just about delivering a well-founded and promising innovation process, but also about identifying the effectiveness of the innovation. Identifying the impact of the innovation and what can be learned from how the innovation process

was implemented provides valuable lessons for follow-up activities, other contexts and future innovations. With educational innovations increasingly coming under scrutiny and educational institutions often going along with trends and hypes – not to mention the speed at which innovations succeed each other – the question arises whether all these innovations truly benefit education. While innovations do have that ambition, they do not necessarily lead to immediate improvements in education. This highlights the importance of evaluating to what extent educational innovations are truly effective and what the returns, or lack of returns, are (Earl & Timperley, 2015).

Construing **effectiveness** in the most narrow sense of the word, it could be taken to refer to the learning outcomes of learners. Here, the question is: does the innovation improve learners' performance, or learning outcomes? This aligns closely with cognitive focus as a foundational principle of education (Appels et al., 2022; Biesta, 2009; Hofman et al., 2013; Kember et al., 1997; OECD, 2021). But this focus detracts from other outcomes that are also achieved, for education has a much broader remit than merely viewing the learner as an empty vessel, or black box, to be filled with knowledge. Educational efforts also focus on attitude, skills and personal development, for example (Biesta, 2009). By the same token, fostering learners' interest and motivation for a particular discipline is also considered an important outcome of education. It may well be that the impact of an educational innovation is reflected not so much in the cognitive learning outcomes of learners but in non-cognitive aspects such as, for example, stronger motivation to engage with the subject or topic. It may, as a secondary effect, also improve the motivation of other stakeholders.

A lot of research has been carried out to deconstruct the complex phenomenon of effectiveness, as it is evident that the outcomes of educational innovations do not come about overnight. It involves a complex interplay of multiple, interacting factors. The CIPO model (see Figure 1) is a helpful tool for categorising different elements relevant to educational processes (Scheerens, 1992, 2015). The model provides pointers for visualising the impact and effects of educational innovations.

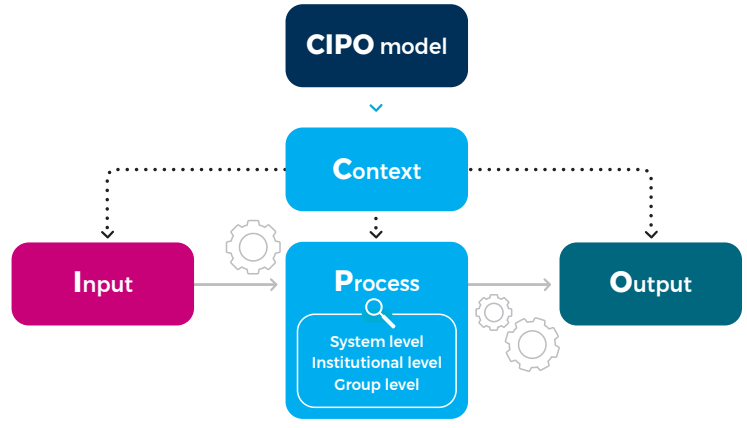


Figure 3 CIPO-model

CIPO stands for: Context, Input, Process and Output. **Context** relates to aspects such as demographic characteristics of the educational institution, the size of the institution or economic developments that influence the quality of education. **Input** refers to aspects such as the characteristics of learners (interests or knowledge level at commencement) and of lecturers (background or qualifications) but also the availability of school buildings, learning material or technology. **Process** revolves around aspects such as forms of instruction, learning activities, the extent to which learners engaged with the learning content or the pedagogical approaches of the educational institution. **Output**, as indicated earlier, involves various outcomes of the educational process, such as learning performance, attitude, motivation, and so on. That is to say, the impact of the educational process, or innovation. For the field lab in particular, the question is: has the educational innovation resulted in a difference in outcomes? Consequently, we apply a **broad focus on the concept of effectiveness** in the field lab.

Evaluating educational innovation

Because evidence-informed innovation is a process that education professionals need to immerse themselves and gain experience in, it is important to evaluate not only the **returns for education** but also the trajectory of this **innovation process** itself (Serdyukov, 2017). From this, lessons can be drawn for adapting or fine-tuning subsequent or other innovation processes. It is therefore advisable to formulate goals about intended learning outcomes of the evidence-informed innovation process beforehand and to evaluate them during and/or after the process.

A key question in evaluating the effectiveness of evidence-informed educational innovations is the extent to which **expectations** are met. This can be done by looking at the goals that were set beforehand and the description of the ideal situation envisaged with the educational innovation.

Development-focused self-evaluation of educational innovation

Evaluations are typically initiated from one of two underlying perspectives – the accountability perspective or the developmental perspective (Nevo, 2002; Nisbet, 1988). The **accountability perspective** is aimed at reviewing predetermined goals in respect of deliverables, outcomes, and so on. The results achieved are juxtaposed against the goals to determine the extent to which the goals have been accomplished. An accountability evaluation is often imposed by an external party (government, grant provider, etc.).

In the **developmental perspective**, the evaluation is aimed at improvement, with a focus on self-imposed development goals. This evaluation is intended mainly to initiate a dialogue that will lead to developmental or improvement initiatives. Although these perspectives can be theoretically distinguished from each other, it is more useful to consider them as forming a continuum with each perspective at the extremes. In practice, an evaluation will fall somewhere in between and have features of both perspectives.

An important distinction between these two perspectives lies in the difference between the goals that are pursued. With the *Evidence-informed educational innovation* field lab, there will be internal expectations; the various sources of evidence should be used to test assumptions related to the effectiveness of educational innovations. There is no external obligation or regulatory framework that explicitly imposes these goals. Rather, it is about goals that educational institutions and education professionals themselves would like to achieve. Therefore, the evaluation of the educational innovations at the heart of the field lab proceeds from a developmental focus on achieving internal goals and how innovative educational practice can be developed and improved on an ongoing basis.

An underlying assumption is that education professionals themselves take the initiative, within the field lab, to scrutinise and evaluate the educational innovation they are working on. This approach is consistent with the concept of self-assessment (MacBeath, 1999; Vanhoof & Van Petegem, 2022). **Self-evaluation** can be defined as a cyclical process in which the organisation or team – on its own initiative and from an overarching, quality-care perspective – systematically describes and assesses aspects of its own performance with the aim of bringing about quality development (Faddar, 2018; Vanhoof & Van Petegem, 2022). In the field lab, we therefore use developmental self-assessment to evaluate the evidence-informed educational innovations that have been implemented.

Level of evaluation

Earl and Timperley (2015) highlight the versatility of an educational innovation and point out that it is often not limited to a single goal or target group. Before initiating an evaluation, it is essential to identify the stakeholders who will be impacted by the educational innovation. It is also important to scrutinise the process in addition to considering the outcomes (Serdyukov, 2017).

As outlined above, the intended goals in the context of the *Evidence-informed innovation of education* and *Effectiveness of educational innovation* Field labs are goals that have been formulated by the educational institution or a team of education professionals. These goals may relate to different levels in the educational organisation, such as the level of **learners**. The primary educational process is, after all, geared to the development of learners. However, it may also be that the educational innovation is designed primarily to reach **lecturers**. One conceivable outcome may be that the innovation allows lecturers to adopt a more efficient assessment method, thus saving time. Goals can also be formulated at the level of the **organisation**, such as introducing new technology that allows the educational institution to put its vision of blended learning into practice.

Two models for evaluating the effect and impact of educational innovations

How do we set about identifying the effects and impact of evidence-informed educational innovations on different levels of participants and the organisation? There are various frameworks that can serve as a structure for doing this in a systematic way.

If we want to proceed from the question of what effects and impact an educational innovation has, Kirkpatrick (1996) provides a workable, straightforward model that can be used in different contexts. This model, which was developed to identify the impact of learning interventions, distinguishes four levels at which effects can be evaluated. These levels can be depicted in a pyramid (shown in Figure 4). Because an educational innovation can be conceptualised as an intervention aimed at fostering change in and learning by the educational professionals involved, the model is well suited to the context of the Field labs.

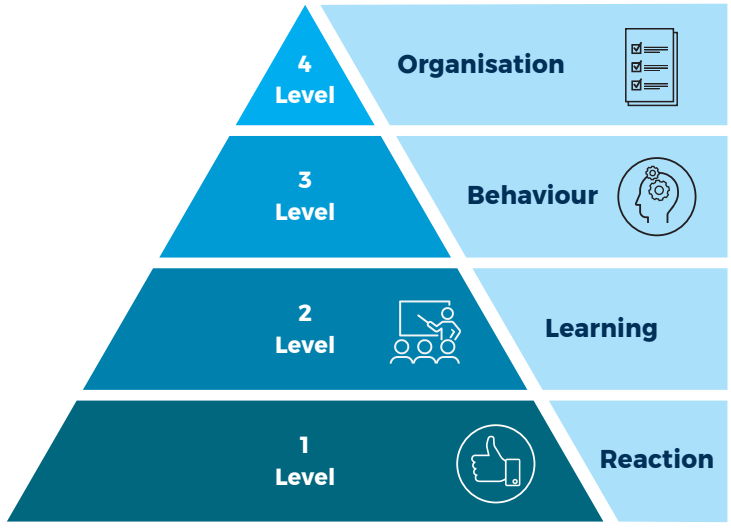


Figure 4 Four levels of criteria to evaluate an intervention according to Kirkpatrick (1996). The levels progressively bring into focus the impact of the intervention on participants and the organisation.

The meaning of the different levels in the pyramid can be explained as follows:
Level 1: Reaction. The first level concerns an initial reaction, primarily the **satisfaction** of all stakeholders in the educational innovation. One question that can help to gauge reactions is the following: *"To what extent is the learner or lecturer satisfied with the teaching innovation, the change in the learning environment or the technology introduced in the learning environment?"*

Level 2: Learning. The second level of criteria is about the **learning process of the participants**. More specifically, this concerns the learning effect that has taken place. Questions that can help identify the learning effect include: *"Did the learner gain more or different knowledge from the educational innovation?" "Did the innovation lead to new insights for the learner?"*

Level 3: Behaviour. The third level in the model pertains to behaviour. When considering the effects of educational innovation, we can also look at whether the innovation has also led to a **change in behaviour for the participants**. One question that can help identify the change in behaviour is: *"To what extent did learners' behaviour change as a result of working with the educational innovation?"*

Level 4: Organisation. Within the fourth level, we examine whether effects have also been achieved at the organisational level. Questions that can help identify a **change in the organisation** include: *"Does the educational innovation also affect student progression rates within the institution?", "Has the innovation brought about increased efficiency?"* or *"Is the evaluation process within the educational institution now more accurate?"*

In addition to the Kirkpatrick model, which is predominantly output-oriented, the Dialogic Model of Impact (DMI model, also called the Warwick model) aims to generate a broader picture that offers opportunities for upscaling (Brown, 2019). The DMI model focuses on rendering explicit various characteristics of the innovation, to adequately contextualise its impact. It also extends to making impact visible at different levels, including the learner and the lecturer levels. The DMI model distinguishes between the following impact domains:

1. The context of the innovation setting
2. The problem or driver for innovation
3. Details about the innovation and how it is expected to bring about change
4. Activities and interactions pertaining to the introduction and implementation of the approach
5. Learning as an outcome of these activities and interactions
6. Change in behaviour and the extent to which an innovation is adopted
7. What difference has behavioural change made?
8. Redefining values by revisiting what is possible in relation to the innovation.

The two models, which are characterised by a common denominator, also provide a lot of scope for approaching the different levels or domains from several angles. Here, we can use two perspectives that need not be mutually exclusive, which means it is possible to combine both perspectives, either in succession or in an integrated way.

From a qualitative approach, the effectiveness or impact of the innovation can be analysed by retrieving rich, in-depth information as part of the evaluation. The focus comes to lie much more on the exploratory, refining and descriptive aspects of an evaluation. Evaluation questions such as "*How…?*" or *"What impact…?"* are central to this approach. This type of evaluation can be organised on a small scale, for instance with interviews or a focus discussion with some of the participants of the field lab.

An evaluation can also be initiated from a quantitative approach, which allows for information to be gathered relatively quickly. The aim of this approach is to obtain a general, broad picture of the impact of the field lab on the participants, which allows for the information to be expressed measurably in numbers. Evaluation questions such as "*To what extent…?*"

or "*In what degree…?*" tend to be central in this approach. In principle, all participants of the field lab are asked to take part in this evaluation.

Outro

The theoretical insights described here serve as background to the *Evidence-informed educational innovation with IT* and *Effectiveness of educational innovation with IT* Field labs. While this is not a comprehensive overview, it does provide the background to the development of the Field labs. Joining forces and combining and integrating different sources of evidence appear to be pivotal in initiating successful innovations. Ultimately, this is what the Field labs are all about!

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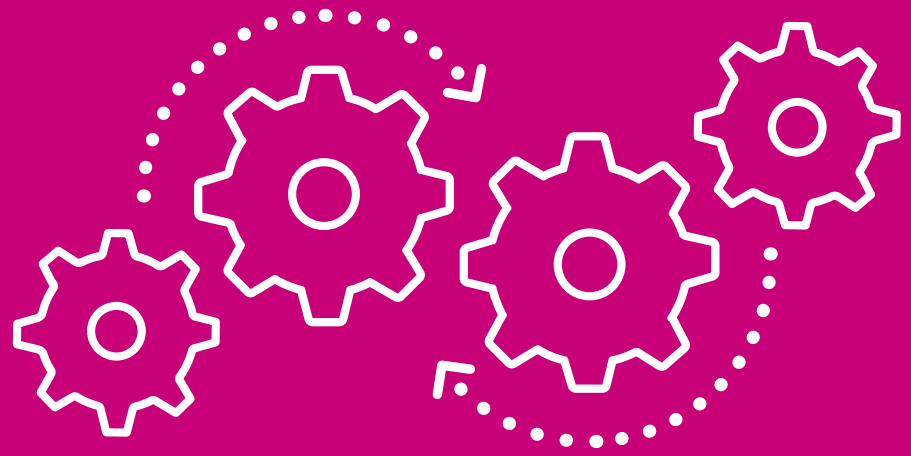
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Modelling examples

Introduction and methodology

In this chapter, six modelling examples are described in the form of interviews with colleagues who work in higher education. The interviews showcase recent innovation projects undertaken by the interviewees and the methodology applied in these projects. They therefore illustrate, or serve as a modelling example of, the methodology described in the theoretical framework above.

Although this methodology is applicable to a wide range of educational innovations, the focus in the interviews is on innovation relating to the *Evidence-informed innovation of education with IT* and the *Digital education of practical skills*.

The following interviews are included:

- **Interview with Dr Ellen Rusman** *(Digital education of practical skills)*: this interview focuses on the development of the 'Pe(e)rfectly Skilled' method. Interactive and practice-based skills education is becoming increasingly important in higher education and, using this method, students receive online support through video-enhanced rubrics to learn practice-based skills in formative assessment, giving feedback and receiving self, peer and expert feedback.
- **Interview with Astrid Timman-Jacobse and Dr Maurice Magnée** *(Digital education of practical skills)*: this interview focuses on the development of the 'Enriching the learning environment with VR' method, using a game in which students practise holding intake interviews and their communication skills in a VR simulation.
- **Interview with Dr Stan van Ginkel** *(Digital education of practical skills*): this interview focuses on the development of the VR tool 'Presenting with impact'. In this tool, students receive instructions and learn in various settings (classroom, theatre, etc.) to give presentations and receive feedback on aspects such as their speaking speed, pitch and eye contact.
- **Interview with Dr Siema Ramdas** *(Evidence-informed innovation of education with IT)*: this interview focuses on implementation of the 'VU Mixed Classroom Educational Model'. This is an educational approach that builds on differences (e.g. in religion, gender, sexual orientation, ethnicity, nationality or socioeconomic status) to enrich the learning experience for all students. Differences and possible tensions between perspectives are used to stimulate critical thinking and generate creative solutions.
- **Interview with Charlotte Meijer** *(Evidence-informed innovation of education with IT)*: this interview focuses on the development of the 'Canvas Student Friendly' project,

which considers the question: '*How can you use Canvas [the communication platform for courses at VU Amsterdam] in such a way that students never miss anything and can easily find the information they need*?' The aim of Canvas Student Friendly is to ensure that students no longer waste time searching for things, as this time can be better spent on learning.
- **Interview with Dr Jessica Zweers** *(Evidence-informed innovation of education with IT)*: this interview focuses on the redesign of a Numeracy in Chemistry module, as many students lack the basic numeracy skills required to successfully complete the module.

Structure of the interviews and the thermometers

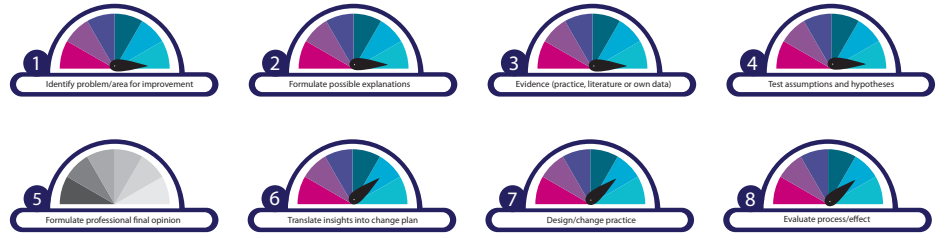
The interviews are structured according to the eight steps presented in the theoretical framework, and based on four themes:
- Background to the problem
- Formulating the hypotheses
- Testing the hypotheses
- Conclusion and follow-up actions

As the interviewees were not aware of the eight-step methodology prior to the interviews, it is possible that not all of the steps are addressed in their projects. This is not a problem, of course, as there is more than one way to achieve a reliable, validated innovation. The projects described in the interviews are also all still works in progress, which means that the last step in particular (evaluate process/effect) was not necessarily complete.

To give an indication of which of the eight steps are covered in the interviews, we use thermometers. Note however that these thermometers do not say anything about the quality of the innovation, but only serve to indicate which steps are included in the interview as an example. The fact that we have selected these projects shows just how impressed we are with them and that we believe that they are very good examples.

Modelling example – Pe(e)rfectly Skilled

Interview with Dr Ellen Rusman



Background to the problem

Which problem does this innovation address?

The online Pe(e)rfectly Skilled method, developed by the Open Universiteit, aims to teach and motivate students to use practice-based skills, as interactive and practice-based skills education is becoming increasingly important in higher education. Using this method, students receive online support through video-enhanced rubrics to learn practice-based skills by providing formative assessment, giving feedback and receiving self, peer and expert feedback. Video-enhanced rubrics integrate textual analytic rubrics and video fragments that use role models and examples. Plenty of practice and good feedback are essential for learning practice-based skills. However, as classes increase in size, it is becoming more difficult for students to practise as much as they should under supervision, and to receive good personalised feedback.

The Pe(e)rfectly Skilled method has been developed to ensure that students are able to practise more often and that they receive timely and good feedback, so that they can work on developing their skills more effectively. Using peer feedback can also reduce the work load for lecturers.

The method has been developed for students who are required to learn oral presentation skills in various modules in the law department at the Open Universiteit (OU) and Maastricht University and in the psychology department at the OU.

How did people become aware of the problem?

Specific cases in day-to-day teaching practice/lecturers' time constraints

The team became aware of the problem as a result of their experiences in their day-to-day teaching practice. Lecturers in higher education are faced with an increasing workload due to the increase in the number of students per lecturer. Lecturers therefore have less time to give sufficient (repeated) and personalised feedback, which affects the quality of the students' interactive and practice-based skills education. However, regular practice, preferably in a variety of situations, and feedback are needed for a student to learn a skill properly. These experiences were therefore the main reason to develop the Pe(e)rfectly Skilled method.

Current curriculum

Because of these constraints, skills are often practised just once within the curriculum. However, to really learn a skill, students need to practice regularly and in a structured manner, but these opportunities are simply not available in many curricula. Lecturers also vary in the time that they spend on practical skills, and this lack of structure in the curriculum regarding the training of practice-based skills was another important reason to develop this method.

Previous projects

The Pe(e)rfectly Skilled method is based on a previous method that was funded by the Netherlands Initiative for Education Research (NRO) – the Viewbrics method. This method was developed to teach interdisciplinary skills in secondary education (Rusman, Nadolski and Ackermans (2019), see nro.nl/sites/nro/files/migrate/viewbrics-rapport-digi_def_totaal.pdf (in Dutch)).

Before the Viewbrics method was implemented, feedback was given using textual rubrics. However, research conducted by the Open Universiteit and others showed that using this blended method for formative assessment and providing and receiving feedback via video rubrics achieved better results (improved development of skills, richer mental models) than existing forms of skills education (Ackermans, 2019). The largest effect was achieved using the structured formative assessment method as, when this method was implemented, it made no difference whether textual or video rubrics were used.

In the Viewbrics method, textual analytic rubrics were combined with videos to illustrate the skill (role models, examples) in a single criterion. These rubrics were developed for three skills – working as a team, processing information and presenting – which are the skills required the most often in project-based education. The rubrics consisted of clusters of skills, and each cluster contained sub-skills with four competence levels. The descriptions in the rubrics made use of skills analysis that is based on the work of Van Merriënboer and Foshay (1998; training for complex skills). This method therefore required a skills analysis to be made to determine the required competence level for each skill. A formative cycle of self, peer and expert feedback was also developed based on the work of Hattie and Timperley (2017; The formative assessment cycle), Shute (2008) and others.

The team came up with the idea for Pe(e)rfectly Skilled by asking the question: 'Do students and lecturers experience a difference in the efficiency, effectiveness and attractiveness of the method for learning skills, when comparing the feedback provided by a lecturer and the peer feedback provided in the Pe(e)rfectly Skilled method?'

Information in the academic literature

As well as being informed by day-to-day educational practice, the team also obtained information from the academic literature. The team therefore analysed and developed solutions to practical problems based on knowledge generated by academic research. This information provided the ingredients needed for the development of the Pe(e)rfectly Skilled method. In developing the method, the design-oriented research team constantly sought to translate existing research into design requirements. In other words, the information from the academic literature was constantly transcribed into problems experienced in current educational practice.

For example, research was analysed on the learning effects of supporting a formative assessment cycle and self-regulation (Black & William, 2009; Zimmerman, 2008) and on how to effectively provide and receive feedback (Hattie & Timperley, 2007; Shute, 2008). Peer feedback is often used in both secondary and higher education, and research shows that good peer feedback can support the learning process, both for the provider and the receiver of the feedback (Filius et al., 2019). For the person providing the feedback, writing the feedback can help them to form a clearer idea of the expected outcome and to develop critical analytical skills. The receiver of the feedback, on the other hand, discovers which competences they already have and which they need to develop. Good peer feedback also reduces the lecturer's workload.

Research by the OU also shows that better results are obtained when people provide feedback after watching video rubrics than after reading textual rubrics (Ackermans et al., 2021). For example, students gave their peers more feedback after watching videos than after reading text. Also, the feedback that they gave was less likely to consist of non-specific words such as 'good', 'poor' and 'better'. Students who used video rubrics therefore used fewer non-specific words and more words in each comment. These two findings show

that the use of video rubrics can improve the quality of the feedback. Research also shows that providing feedback once is not effective, but that it should be regularly and consistently repeated.

The benefits of using technology to support and streamline the formative assessment cycle, the giving and receipt of feedback, reflection and self-regulation were also examined during the development of the Pe(e)rfectly Skilled method (Rusman et al., 2014).
In summary: all of these academic insights were translated into design requirements for the Pe(e)rfectly Skilled method.

Did the research question need to be changed or refined?

As mentioned above, the Pe(e)rfectly Skilled method was based on a previous method, the Viewbrics method (Rusman, Nadolski & Ackermans, 2019). The research question relating to the Pe(e)rfectly Skilled method did differ from that for the Viewbrics method. The research question for the Pe(e)rfectly Skilled method was: 'Is skills education using the Pe(e)rfectly Skilled method plus lecturer feedback more effective, attractive and efficient than education using peer feedback alone?' The researchers did not need to change or refine this question during the project. Regular meetings were held with all of the lecturers, experts and researchers in the core team for the duration of a project, in which decisions concerning the design were discussed. These meetings also resulted in various ideas for new research projects, but the research question was not changed or refined as a result of this.

Formulating the hypotheses

Did the team have a possible explanation for the problem from the start? And, how were the hypotheses formulated?
The team did have a possible explanation for the problem from the start, based on insights from the academic literature and experiences in teaching practice (experiential knowledge from Viewbrics and lecturers' own experiences). The hypotheses were therefore formulated based on these.

Were the hypotheses formulated together with colleagues, students or other stakeholders? If so, did this produce new insights?
The two lead researchers were mainly responsible for formulating the hypotheses, although with input from lecturers in the core team. These researchers and experts (interaction designer, programmers, education technologists) also contributed to the development of the method during regular, bi-weekly meetings. Use was therefore made of the experiential knowledge of these lecturers and experts. This experiential knowledge was often compared with the knowledge gained from the theory (combination of practical experience and theory), resulting in the development of a well-founded method and hypothesis.

Which hypotheses were finally formulated? Did they require much fine-tuning?
The final hypotheses were formulated as follows:

- In both domains (law and psychology), the Pe(e)rfectly Skilled method improves students' competence in skills to a similar extent for both feedback formats (TPS (Teacher-Peer-Self, PS (Peer-Self)) and both contexts (RW 1 and 2, Psychology).
- As a result of the first hypothesis, the Pe(e)rfectly Skilled method reduces the lecturers' workload (because the PS format does not require teacher input).
- The feedback received is experienced as (a) sufficient and (b) comparable for both feedback formats.

These hypotheses required little to no fine-tuning during the project. The only adjustment that was made – as a result of the COVID-19 pandemic – was that the intended blended implementation of the project at Maastricht University became a fully online supported pilot project.

Testing the hypotheses

On what basis was an attempt made to confirm or refute the hypotheses? In other words, how did you find the evidence required to confirm or refute the hypotheses?
The research team attempted to answer the research question by collecting data. Interviews were conducted, performance data (rubric scores) was collected and the research team developed various questionnaires, for which different validated scales were used. For example, the research team monitored student motivation using the Intrinsic Motivation Inventory (IMI) by Ryan & Deci (2000). It also used the Technology Acceptance Model by Ahmad (2008; TAM model), which was developed to predict the use of new technologies, including websites. Other validated scales that were used included the Feedback Acceptance Scale (Bell & Arthur, 2008) and the System Usability Scale (SUS). The SUS is a questionnaire that was developed by John Brooke (1996) to measure the usability of a website or an app, taking into account the context in which it is used.

A combination of quantitative and qualitative data was therefore used; this is a mixed methods approach based on quantitative (questionnaires) and qualitative (interviews) analysis.

What was the result? Was it possible to confirm or refute the hypotheses?
Analysis of the results should be complete by the end of 2022. Initial results from one of the pilot projects would however seem to suggest that the hypotheses will be confirmed. The initial reactions of lecturers and students who are using the Pe(e)rfectly Skilled method are also positive. For example, several students have indicated that they are satisfied with the online support (being able to practise where and when they want) and with the 'skills wheel', which is used to display all of the feedback given in a session. This makes it possible for students to see at a glance which sub-skills they are already competent in and which require more practice. More information on the project's progress can be found on the project web page: ou.nl/leren-en-innoveren-met-ict-projecten-pe-e-rfect-vaardig-rolmodellen-en-peer-feedback. The results will be published at: surf.nl/peerfect-vaardig.

Conclusion and follow-up actions

Did the results produce a solution to the problem? If so, what was your professional final opinion?
Although it is not yet possible to answer this question definitively, initial results would seem to confirm the hypotheses.

How have the results been implemented in educational practice?
Once the pilot project has been completed, it is the intention that the Pe(e)rfectly Skilled method will be implemented on other courses and for other skills. The researchers also hope that the method can be used in other domains and perhaps even in other organisations. The method could also be implemented in other online systems, which would increase its reach and make it more widely available. However, these plans depend on developments taking place in the organisation, as these determine whether something that has been developed will actually be implemented.

How were colleagues kept informed?
Various methods have been implemented to inform colleagues about the project. For example, there is an external steering committee consisting of experts from the education sector, which is kept informed of the study and advises the research team. Furthermore, a workshop on the method was given at the OU Education Day, and a project Kumospace has been set up; Kumospace is an informal virtual meeting room in which all kinds of objects can be placed and where people can join in whenever they like. The research team also won the prize for the OU 'Education project of the year 2021' and gave a presentation during the SURF Education Days and at the EPIC International Conference for colleagues in higher education (see: slideshare.net/DeOnderwijsdagen/peerfectvaardig-online-vaardiger-ellen-rusman-en-rob-nadolski-ou-owd21 and versnellingsplan.nl/wp-content/uploads/2022/06/EPIC_Peerfectly-Skilled-proficiently-skilled-through-online-training-Ellen-Rusman-and-Rob-Nadolski.pdf).

What has been done to assess the effects of the change?
The effects of the change were assessed in three pilot projects, two in the law department at the OU and Maastricht University, and one in the psychology department at the OU. It is however too early to draw conclusions on the effects of the change as the project will not be completed until the end of 2022 and the results have not yet been analysed.

Would you like to know more about the Pe(e)rfectly Skilled project?
- ou.nl/leren-en-innoveren-met-ict-projecten-pe-e-rfect-vaardig-rolmodellen-en-peer-feedback (Open Universiteit research web page)
- surf.nl/peerfect-vaardig (SURF research web page)
- slideshare.net/DeOnderwijsdagen/peerfectvaardig-online-vaardiger-ellen-rusman-en-rob-nadolski-ou-owd21 (Education Days presentation)
- versnellingsplan.nl/wp-content/uploads/2022/06/EPIC_Peerfectly-Skilled-proficiently-skilled-through-online-training-Ellen-Rusman-and-Rob-Nadolski.pdf (Pe(e)rfectly Skilled presentation)

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Modelling example – Enriching the learning environment with a virtual client

Interview with Astrid Timman-Jacobse and Dr Maurice Magnée



Background to the problem

Which problem does this innovation address?

The ‘Intake’ VR simulation was developed by iXperium Health at the HAN University of Applied Sciences in cooperation with The Simulation Crew (who produced the app). iXperium Health is an innovation lab that focuses on technology in the health and social care sector, and with which four HAN schools are affiliated (Health Studies, Social Studies, Sport and Exercise, Allied Health).

Interaction is important in the health and social care sector, and the quality of the interaction can even determine the success of an intervention. Important elements of this interaction are making contact and communication. Previously, students would practise this in role play sessions with other students and actors, and their skills would be assessed in sessions with actors. However, students found the opportunities to practise to be limited, and the role play situations to be inconsistent. The feedback and evaluation provided by the lecturers was also found to be subjective at times.

A VR simulation gives students the opportunity to practise more consistently and in a safe environment, so that they can practise when, where and as often as they want. Students can practise conducting an intake interview and their communication skills (listening, summarising and questioning). They take on the role of a health centre employee who is conducting an intake interview with Max: a 20-year-old man with a mild form of an autism spectrum disorder (ASD). The student sits behind a desk with a monitor on which they see tips on how to conduct the intake interview and suggestions for topics of conversation. The student has to follow the procedure for conducting an intake interview, and Max’s

response lets them know if they deviate from this. The virtual client responds in real time, so that each student practises a different interview and receives personalised feedback. This allows students to closely monitor their progress and lecturers can see which particular skills a student needs to focus on.

How did people become aware of the problem?

Discussions with students

The problem came to light through discussions with students. Each year, the degree programme committee received comments and questions about the assessments. To analyse these comments and questions objectively, the committee developed a questionnaire together with the students. This showed that the students were happy with the transparency, organisation and facilities provided, but that the actors and the feedback were not always satisfactory. For example, they considered the feedback to be subjective and the situations used in the assessments to be inconsistent, which they did not think was fair. Discussions with students also brought to light the fact that they sometimes felt disadvantaged because they were nervous about performing in front of a group, and that they sometimes could not absorb the feedback because they were so stressed. The feedback from students was therefore one of the main reasons to develop the virtual client Max.

Information in the academic literature

To explore the problem, the team started by mainly considering medical practice. Later in the process, when developing the application, more use was made of the literature and the team's theoretical knowledge. The literature was mainly in the field of education, and concerned the theory, teaching practice and feedback, as well as the opportunities provided by VR.

Did the research question need to be changed or fine-tuned?

The research question did not need to be changed or fine-tuned. Thanks to the discussions with students, the problem as experienced in practice was quickly identified and the team could start to look for a solution.

Formulating the hypotheses

Did the team have a possible explanation for the problem from the start? How were the hypotheses formulated?

The team did have a possible explanation for the problem from the start. The lecturers had noticed the students' dissatisfaction with the role play sessions for practising conversation skills, and the questionnaires completed by the students confirmed this. The problem was therefore identified through practical experience and the hypotheses were based on this.

Were the hypotheses formulated together with colleagues, students or other stakeholders? If so, did this produce new insights?

A wide range of experts was involved in developing a solution to the problem, including lecturers and students in speech therapy, occupational therapy, physiotherapy, dental hygiene, social work and nursing, as well as the app developers. The team therefore recognised the benefits of interprofessional collaboration: 1+1=100.

The team decided on the VR application based on the knowledge already available in the team. Students were also involved in the development of the VR application, for example by demonstrating practical situations for the programmers, as examples to be included in the VR simulation. Students also had input into the design, including the client's appearance, the VR setting and the client's responses. Finally, students from the IT programme developed a dashboard to display the scores.
The application was fine-tuned after being tested by students, lecturers and professionals in the field. After all, these are the people who will use the application. The feedback that they provided resulted in new insights, based on which the hypotheses were formulated.

Which hypotheses were finally formulated? Did they require much fine-tuning?

The following hypotheses were formulated at the start of the project:

- *The VR application provides objective feedback and consistent practice settings.*
- *The VR application provides a safe learning environment for students in which it is possible to make mistakes without serious consequences.*
- *The VR application makes it possible to practise when and where the student wants.*
- *The VR application ensures that students become acquainted with professional practice.*

Testing the VR simulation was part of the development process, and the feedback that this generated was used to improve it. Once the application was used in the teaching setting, the researchers formulated new hypotheses which they could test. One of these was: 'This VR application means that students are able to practise their communication skills more

often than before'. The application was completed and implemented during the COVID-19 pandemic. As a result, the team discovered that students were able to practise more if they could use VR. The students were sent VR headsets so that they could practise as often as they wanted. On the integrated dashboard, which was also developed by students, they could see their own scores and try to improve their skills. On another dashboard, also developed by the students, lecturers were able to see how often students were practising. The application was found not only to create a safer learning environment, but also to reduce performance anxiety as students did not have to watch each other practise. Students could also read their feedback before sharing it with others, rather than receiving feedback in front of the class. As a result of this, a new hypothesis was formulated: 'Using VR reduces performance anxiety among students'. As more people are using the application, other degree programmes and institutions are carrying out their own research in which the team is also involved. New hypotheses are therefore being formulated and new research carried out; this is a work in progress.

Testing the hypotheses

On what basis was an attempt made to confirm or refute the hypotheses? In other words, how did you find the evidence required to confirm or refute the hypotheses?
Different kinds of research have been, and are still being, carried out. The first phase of the project mainly consisted of educational design research. In each phase, Max was improved, step-by-step, and presented to the students with the question whether this was what they had in mind. To start with, use was mainly made of practical experience to confirm or refute the hypotheses. The team had lots of informal chats with students about their use of the VR application and questionnaires were filled in.

The team is now focusing on validating the application, for which validated and the team's own questionnaires are being used. One of the validated questionnaires is the Unified Theory of Acceptance and Use of Technology (UTAUT), developed by Venkatesh et al. (2003). Another validated questionnaire is The Arc's Self-Determination Scale by Wehmeyer and Kelchner (1995). Use was also made of qualitative interviews, and the team developed its own questionnaire on the students' experiences, if they provided feedback. The education data of students was also analysed, using a dashboard that was developed by IT and multimedia design students. Using this dashboard, data from students that use the application can be read back and analysed by the researchers. The dashboard shows how the tool is used, any problems that the students have, what they practise the most and whether their score is improving or not. The data is immediately available for analysis. Students can also review the same data and monitor their own learning process.

What was the result? Was it possible to confirm or refute the hypotheses?
As the application continued to be developed, new hypotheses were formulated and tested. Some tests still need to be carried out and the group is too small to be able to draw any statistical conclusions, although the team has received a lot of positive feedback from the students. Students think that it is a good way to practise and become acquainted with the workplace. Thanks to the application, the students were able to practise their communication skills more often than before. They could use the VR headset at home for eight to ten days and practised on average four to six times, which is estimated to be more than when students practise in lessons. Students also found it to be a safe environment in which to practise, as no one was watching them and they could make mistakes without any serious consequences. The students also appreciated being able to practise where, when and as often as they wanted, without the feeling that people might laugh at them. The application can therefore also reduce performance anxiety among students. The students told the researchers that they also learned more about communication skills and how to conduct an intake interview than they did in lessons.

There was also some negative feedback; that the virtual world was sometimes a little unreal, and some students, mostly those who like to be in control, found VR scary. Some students also felt dizzy using the VR headset. It was noted that the application turned out not to work properly if a student stuttered.

Conclusion and follow-up actions

Did the results produce a solution to the problem? If so, what was your professional final opinion?
The project is still ongoing, so it is not possible to provide concrete answers to this question. The technology cannot yet be used to carry out thorough comparative effectiveness research and still needs to be developed further. For example, the team is currently working on developing different scenarios and solving technical issues, based on logbooks and observations. This is therefore a research project rather than a fully developed technology. Even so, the positive feedback from students indicates that this VR application could be a solution to the problem.

How have the results been implemented in educational practice?
The positive responses from the students show that they enjoy learning communication skills in the VR application and that it improves their skills. After all, people mainly learn communication skills by communicating, but there is not always the time or opportunity to do this in the classroom. Neither can students endlessly practise their communication

skills in the real work setting, but they can practise them as often as they want with the virtual client Max, from which they learn a lot. The application has now been implemented in other degree programmes, and the aim is to expand this and to collaborate with other degree programmes to produce an even better VR application. There is however still a long way to go with the implementation of VR applications in education. After all, they take a lot of time and resources to develop, and institutions need to carefully consider how they will be implemented and whether they benefit the curriculum.

In general, however, it is possible to conclude that VR presents a lot of opportunities for education, especially in providing students with practical experience that cannot always be achieved in the workplace setting.

How were colleagues kept informed?
Each HAN degree programme in the health and social care domain has an ambassador who is affiliated to iXperium Health. These ambassadors are tasked with calling attention to and implementing technology in educational practice and the professional field. This concerns not just the use of VR, but any technology that can be implemented in the health and social care sector. The ambassadors also organise inspiration sessions for lecturers and students, in which they can try out various tools.

The ambassadors meet regularly to discuss and exchange ideas, which they then take back to their own degree programmes, creating opportunities for cross-pollination. The ambassadors consider how new tools can be implemented in their degree programme and curricula, and this ensures that new ideas and insights are spread throughout the organisation.

What has been done to assess the effects of the change?
The effects of the change are being analysed using validated and own questionnaires, education data and student feedback. The application itself is currently also being evaluated by a student, who is analysing all of the logbooks. Observations of students who use the application are also being analysed. All of these results are being combined to develop Max 3.0. As mentioned above, the application is still being developed and research is still ongoing, so that concrete conclusions cannot yet be drawn about the effects of the change.

Would you like to know more about this project?
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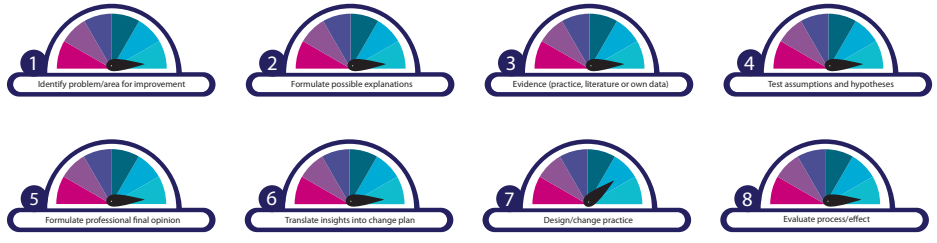
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Modelling example – Virtual reality for learning presentation skills

Interview with Dr Stan van Ginkel



Background to the problem

Which problem does this innovation address?

Researchers at the University of Applied Sciences Utrecht (HU) started the 'Virtual reality for learning presentation skills' project in 2016. Good presentation skills are important, but many young professionals lack these skills, or suffer from performance anxiety. Most degree programmes do not pay sufficient attention to the development of presentation skills. In many cases, lecturers do not have enough time to let every student in their class or on their course practise giving a presentation several times and to provide feedback, and the feedback that they do provide often focuses more on the content than the presentation skills. Furthermore, presentations are often given in groups, so that some students leave the actual presentation up to someone else. Another problem is the worldwide shortage of lecturers, for which a solution needs to be found. The HU is investigating whether innovative technology can help to reduce the workload for lecturers. The researchers believe that the most suitable technology for this is Virtual Reality (VR), as it can be used to simulate a presentation setting. They have developed a VR tool together with a commercial party, called 'Presenting with impact', in which students receive instructions and learn to give presentations or receive feedback on various aspects, such as their speaking speed, pitch and eye contact, in a range of settings (classroom, studio, theatre, etc.).

It is interesting to see how learning to give a presentation using a VR headset can improve students' competence in a skill that is so important in the field of work.

How did people become aware of the problem?

Time constraints

The researchers and skills trainers on the teacher training programme at HU saw that severe time constraints were placed on the practising of skills and receiving feedback. For many years, skills training had been provided for a small group of students, so that everyone had sufficient time to practise and receive feedback. However, the increase in student numbers meant that the groups had become larger, with the result that there was not enough time in lessons for students to practise and for lecturers to provide detailed feedback for every student.

Worldwide shortage of lecturers

There is a shortage of lecturers not just in the Netherlands; the UNESCO Institute for Statistics noted in 2016 that the worldwide shortage of lecturers totalled 69 million (Adubra et al., 2019; Unesco Platform Vlaanderen, 2016). UNESCO, which is an agency of the United Nations, aims to have solved this problem by 2030 as part of the Sustainable Development Goals. Solutions are therefore needed that reduce the workload of lecturers. One of the researchers working on the 'Presenting with impact' tool was therefore invited to demonstrate their findings at UNESCO as part of a possible solution.

Literature search

In addition to practical experience, the academic literature was also used to identify the problem. Research by Chan (2011) shows that young professionals lack adequate presentation skills, and many suffer from performance anxiety (Smith & Sodano, 2011). These are all reasons to focus more on presentation skills in higher education.

Own research

Based on various studies, the researchers have drawn up a set of principles for improving the development of presentation skills:

- Learning outcome
- Learning task
- Example behaviour
- Practise
- Type of feedback
- Peer feedback
- Self-evaluation (Van Ginkel et al., 2015)

The researchers themselves consider time to practise and feedback (from the lecturer, peers and/or online) to be the most important points. Although labour-intensive, they are important

for the development of presentation skills, and must therefore be included in the development of a possible solution.

Education principles

In addition to the aspects described above, the researchers also used their knowledge of education principles. To give an example, students who are required to give a presentation often all receive the same assignment. However, it is better if students can progress at their own rate, so that they continue to be challenged. The researchers therefore wanted to develop a solution in which students work to achieve their own learning outcomes, which is consistent with the principle of constructive alignment (Biggs, 1996; Biggs, 2014).

Did the research question need to be changed or fine-tuned?

The combination of the problems identified in day-to-day teaching practice and the information obtained from the literature meant that the problem definition was clear and the research question did not need to be changed.

Formulating the hypotheses

Did the team have a possible explanation for the problem from the start? How were the hypotheses formulated?

The team did have a possible explanation for the problem from the start. The digital innovation in education (*Digitale Innovatie in Onderwijs*, DIO) research group designs its education based on a model that it has developed for this purpose (see Figure 1). The first step is to consider the skill itself; what exactly is the problem with this skill? The next step is to look at the learning environment; what can be done here? Finally, the team considers how innovative technologies can be used to enrich the learning environment or improve this skill. By following these steps, a solution was sought for the identified problem.

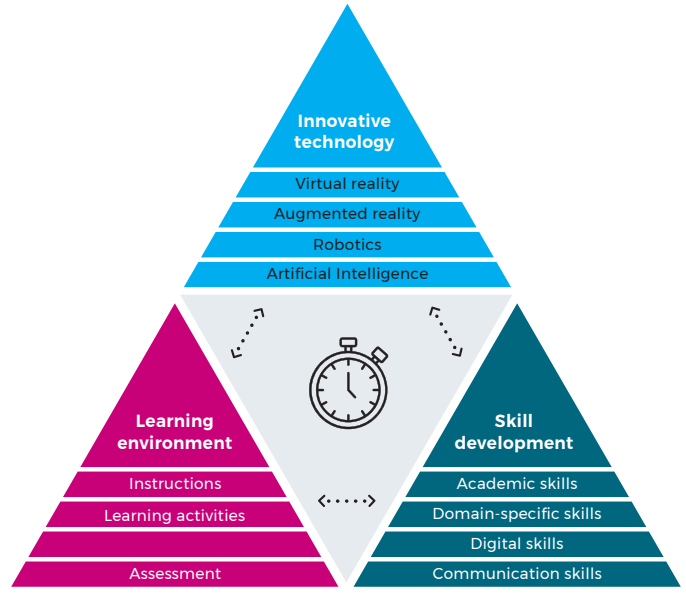


Figure 1 *DIO triangle: skill development, learning environment, innovative technology.* Source: the DIO research group (Van Ginkel & Sichterman, 2022)

Were the hypotheses formulated together with colleagues, students or other stakeholders? If so, did this produce new insights?

The DIO research group consists of 12 to 15 researchers plus several students who assist in the research. Lecturers who are involved in teaching skills also collaborate with the research team, and students participate in the study and provide feedback. The different types of knowledge produced by this collaboration together result in new insights.

Which hypotheses were finally formulated? Did they require much fine-tuning?

The objectives of this project were to:

- Personalise the process by which students develop their presentation skills.
- Ensure that practice opportunities are just-in-time.
- Ensure that there are sufficient opportunities to practise and that sufficient feedback is provided.

The research group also carried out various studies into how VR can be used to learn presentation skills. These studies were mainly related to the third project objective. Various hypotheses were formulated for these three studies:

- An extra practice session in VR provides further benefits regarding the development of presentation skills among students (Boetje & Van Ginkel, 2020).
- Feedback in VR is as effective as feedback from the lecturer (Van Ginkel et al., 2019).

- Computer-mediated immediate feedback is as effective as non-immediate feedback from the lecturer or tutor (Van Ginkel et al., 2020).

Testing the hypotheses

On what basis was an attempt made to confirm or refute the hypotheses? In other words, how did you find the evidence required to confirm or refute the hypotheses?
To confirm or refute the hypotheses, use was made of three research projects, both quantitative and qualitative.

Research project 1 (Boetje & Van Ginkel, 2020)

The first study, which made use of quantitative research, examined the difference between practising presentation skills two or three times. This was done through a randomised pre-test/post-test design. In the pre-test, presentation skills were measured during a face-to-face presentation and the students were asked to complete a questionnaire that also measured performance anxiety. The students were then randomly assigned to two conditions: practising once in VR with feedback and once without feedback (total = 2) or practising once in VR with feedback and twice without feedback (total = 3). The presentation skills were again measured in the post-test in a face-to-face presentation and the students were again asked to complete a questionnaire.

Research project 2 (Van Ginkel et al., 2019)

The second study was a mixed methods study involving a field experiment. A pre-test was carried out among first-year students to measure their presentation skills during a face-to-face presentation and their knowledge of and attitude towards presenting. This group was then split into an experimental group and a control group. In the experimental group, students practised in VR and received feedback in the VR app. In the control group, students had to practise face-to-face and received feedback from the lecturer. At the end, another post-test was carried out to measure presentation skills using a face-to-face presentation and students' knowledge of and attitude towards presenting. The students were also asked to complete a self-evaluation form consisting of closed (quantitative) and open (qualitative) questions.

Research project 3 (Van Ginkel et al., 2020)

The third research project had the same design as the second project and also combined a field experiment with a quantitative and qualitative self-evaluation form. In the first session, the students gave a face-to-face presentation, based on which their presentation skills were assessed. In the second session, the group was divided into an experimental group, which practised presenting in front of a virtual audience and received computer-mediated immediate feedback, and a control group, which practised presenting in front of a virtual audience and received non-immediate feedback from an expert. In the last session, the students again had to give a face-to-face presentation and a post-test was carried out to measure presentation skills, and the students again had to complete a self-evaluation form.

What was the result? Was it possible to confirm or refute the hypotheses?

Research project 1

The first research project confirmed the hypothesis 'An extra practice session in VR provides further benefits regarding the development of presentation skills among students'. A significant difference was found in presentation skills between two and three practice sessions. Both students with and without performance anxiety improve equally on presentation skills when they were able to practice one more time in VR.

Research project 2

In the second project, the hypothesis 'Feedback in VR is as effective as feedback from the lecturer' was also confirmed. In both conditions, the presentation skills and knowledge of and attitude towards presenting significantly improved, but no significant differences were found between the two conditions. In the self-evaluation, the students did say that their experiences of the two forms of feedback were different; feedback in VR was mainly perceived as detailed and feedback from the lecturer as positive and constructive.

Research project 3

In the second project, the hypothesis 'Computer-mediated immediate feedback is as effective as non-immediate feedback from the lecturer or tutor' was also confirmed. No difference was found between the effectiveness of immediate or non-immediate feedback. Furthermore, the presentation skills of the students improved significantly, but no significant difference was found between the experimental and the control group.

Conclusion and follow-up actions

Did the results produce a solution to the problem? If so, what was your professional final opinion?
It is asserted that young professionals lack sufficient presentation skills, while these are important skills to have. Furthermore, some young professionals suffer from performance

anxiety. Practising presentation skills is also a labour-intensive process, while there is a shortage of lecturers.
Research shows that practising giving presentations helps to improve presentation skills and reduce performance anxiety (Boetje & Van Ginkel, 2020; Van Ginkel et al., 2019; Van Ginkel et al., 2020). Also, practising using VR improves the presentation skills of students in a way that does not significantly differ from practising in real life. No difference is seen in the improvement in presentation skills between students receiving computer-mediated immediate feedback and non-immediate feedback from an expert.

The conclusion can therefore be drawn that the VR app contributes to a solution to the problem: practising giving presentations improves presentation skills and reduces performance anxiety, and without the VR app this would considerably increase the lecturer's workload. However, it is shown that it does not matter whether the student receives feedback from the lecturer or in the VR app, which increases opportunities for students to practise without adding to the lecturer's workload.

How have the results been implemented in educational practice?
VR is a valuable tool for creating opportunities to practise giving presentations and provide feedback. However, the use of VR raises some practical questions. For example, not everyone in a class of 25 students can wear the VR headset at the same time. What then is the best way to implement this in practice and what is the role of the lecturer? Furthermore, while there are headsets available in the digital education lab, the logistical aspect of this also needs to be considered: who is responsible for the headsets and can students take one whenever they want to? Technology also dates quickly; what to do about this?

Another point is that it is important to innovate based on an identified problem, as – in this project – this ensured that a solution was found. Evaluation is also an important part of the process: the researchers found that VR can be used to give feedback on eye contact and use of voice, but not on body language, which led the researchers to a new problem, for which they have come up with a new solution. They decided to use an artificial intelligence (AI) app to address the problem of body language. If you film a presentation and upload the film into the app, the app analyses 17 points on the body and shows how these correspond to effective and ineffective gestures based on the literature. This app is currently being developed.

How were colleagues kept informed?
The researchers informed colleagues about the project in various ways. When the project started in 2016, VR was still in its infancy in education. There was a lot of resistance to new innovations, and lecturers who had been teaching in a certain way for many years found new technologies to be intimidating. According to the researchers, it is important to start with those colleagues who are open to innovation and enthusiastic about new technologies, as these colleagues can spread the word.
The researchers also published a lot of articles in highly regarded journals, which came to the attention of UNESCO and led to the researchers being invited to give a keynote speech. The researchers also gave presentations at EPIC and other conferences to inform colleagues from outside the institution. The institution holds an annual education festival, at which they also gave a presentation.

It should be noted that the researchers' objective is not to promote the app itself, as the value lies not in this but in the research projects. It is therefore less about the tool and more about the value of feedback. After all, VR may be just a hype and used less in a few years' time, but the knowledge about the opportunities for providing feedback will remain.

What has been done to assess the effects of the change?
The team analysed the effects of the change in three research projects, from which they concluded that the innovation was effective because it improved students' presentation skills and reduced lecturers' workload.

Meer weten over het project Virtual Reality om te leren presenteren?
- hu.nl/onderzoek/betekenisvol-digitaal-innoveren (domain info + project film)
- hu.nl/onderzoek/projecten/virtual-reality-om-te-leren-presenteren (project info + contact person)
- hu.nl/onderzoek/nieuws/vr-tool-mondeling-presenteren-verder-ontwikkeld-voor-bredere-inzet (project news)
- surf.nl/personal-presentation-trainer (SURF research web page)

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Modelling example – VU Mixed Classroom intervention

Interview with Dr Siema Ramdas



Background to the problem

Which problem does this innovation address?

So many people, so many differences, so many talents: it is this diversity that helps a team to develop more creative solutions, ideas and insights. After all, diverse teams achieve more, as long as the process is supported in the right way. Diversity is about differences and similarities, while inclusion is about making use of each person's uniqueness and belonging. Diversity and inclusion therefore make it possible to work with a good mix of talents, and this is the assumption made by VU Amsterdam; it is also part of the university's educational vision. The first priority of the VU educational vision is openness: "open to diversity in disciplines, nationalities, beliefs, sexuality and academic perspectives. This is what inspires us. After all, being open to differences creates more value, innovation and development. At the VU, you can be who you are" (VU, 2021). Diversity and inclusion are therefore expressly named as important values at the VU, and a benefit. **The VU is also the university with the most diverse student population in the Netherlands**. It therefore requires an educational model that supports this vision, which is why Siema Ramdas was asked to develop the VU Mixed Classroom Educational Model together with a team of colleagues (Ramdas, Slootman & Van der Zee, 2020). The VU Mixed Classroom Educational Model is an educational approach that builds upon differences (e.g. in religion, gender, sexual orientation, ethnicity, nationality or socioeconomic status) to enrich the learning experience of all students. Within this model, use is made of differences and possible tensions between perspectives to stimulate critical thinking, develop analytical skills and generate creative solutions. The Mixed Classroom Educational Model can be implemented in education in three phases (see Figure 2):

- **Sensitising**: Sensitising students to their own frame of reference and the assumptions underlying this.
- **Engaging**: Engaging students to interact constructively with different perspectives present in the classroom.
- **Optimising**: Optimising the learning process of each student by having them capitalise on different perspectives.

An essential element in these three phases is an inclusive and safe learning climate in the classroom.

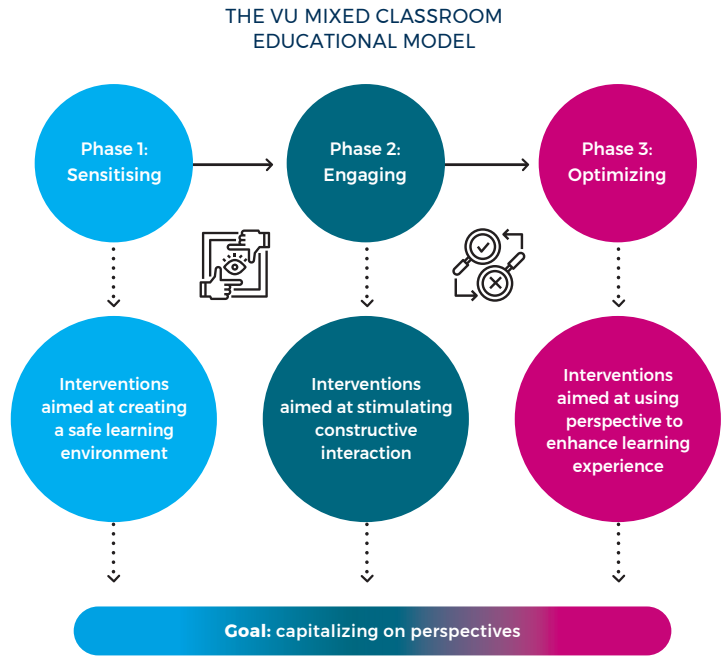


Figure 2 The three phases of the Mixed Classroom Educational Model.

The VU therefore has a well-founded theoretical framework to make use of diversity and create inclusion. However, many lecturers had questions about how to implement this in practice. Siema Ramdas has developed interventions and teaching methods to answer this question, one of which is described in this modelling example. This addresses the question: 'How can societal issues be discussed in the classroom in a way that everyone's perspective can be expressed and students learn from each other?' In a lecture designed together with her colleague Amrita Das, Ramdas starts by creating a safe learning climate, with the exercise 'What's in a name?' In this exercise, the students split up into small groups and talk about where their name comes from. Das and Ramdas then start to introduce the societal issue: 'What are your personal feelings about this issue?' This is phase 1 of the model: students explore their own perspectives. Students are first given the opportunity to think about the issue themselves, after which they share their perspectives anonymously in Mentimeter. Mentimeter is a useful tool for getting students to communicate their perspectives, because its anonymity means that no one is worried about taking part. The Mentimeter answers are then discussed in the class, but the students are never asked who gave which answer. Instead, they are asked whether anyone wants to elaborate on an answer, or to tell the class how they feel about an answer. In this way, the answers remain anonymous and a safe learning climate is maintained. It is then time for some theory: Ramdas provides background information and presents the dilemmas relating to the societal issue, as in a traditional lecture. In phase 2, students split into groups and each group is given a card with a statement relating to the issue, which they have to discuss. However, before they can do this, the groups first need to agree on a group name. This gets them talking to each other at a different level, to break the ice and get them working together, and results in some very creative names. Their discussion of the statement must relate to the theory that they were just given and to the theory that they have read to prepare for this session, plus own experiences and their own knowledge. It is then time for phase 3, in which the findings of the group are discussed with the rest of the class. The idea therefore is not to give a summary, but to use the different perspectives to achieve new insights. Because each group has discussed statements relating to the same theme, further discussion can take place at the meta level, encouraged by the lecturer.

How did people become aware of the problem?

Diversity often ignored

Many lecturers are aware of the many different perspectives in their classroom, but are unsure about how to encourage students to reveal them. Lecturers approached Ramdas to ask how they could get students to give their perspective on a particular statement or problem, and how to encourage students to discuss different perspectives. Many other lecturers did not approach Ramdas with this question, but their teaching would probably also benefit from considering the different perspectives and approaches in the classroom.

Diversity and inclusion can lead to conflict

Lecturers find diversity and inclusion difficult subjects. After all, they often result in controversy, as they can trigger emotions among students. VU Amsterdam is one of the most

diverse universities in the Netherlands, and that can sometimes cause problems. Lecturers are unsure about the best way to deal with differences, with the result that discussions can become heated and even sometimes create an unsafe climate in the classroom. Lecturers may also decide not to discuss a particular subject, as they are worried that it will cause problems. These problems, the associated unsafe climate and the avoidance of certain discussions must be prevented and instead transformed into learning opportunities, and this can be achieved by giving lecturers the tools that they need to accommodate diversity and create inclusion.

Insufficient student participation

Another complaint that Ramdas hears from lecturers is that students do not participate enough in lectures. Lecturers like to see a discussion taking place in the classroom, but not the same or the same group of students dominating the discussion. After all, being able to consider an issue from more than one perspective and building on these differences is an important academic skill for students. Lecturers therefore want students to learn about and be able to consider an issue from different perspectives, but are unable to achieve this in practice, which is why they are looking for ways to increase student participation.

Information in the academic literature

Prior to this intervention, Ramdas had a lot of knowledge on the subject. For example, she had developed the VU Mixed Classroom Educational Model with a team of colleagues (Ramdas et al., 2020). This model is based on some important educational theories, such as constructive alignment (Biggs & Tang, 2011), social learning (Bandura, 1971), the international classroom (Leask, 2013), the diverse classroom (Leask, 2013), inclusive learning and teaching (Hockings, 2010) and the importance of a safe learning climate (Nyguist & Jubran, 2012). Ramdas had also conducted research on diversity (Smit, Radstake, Bertram-Troost & Ramdas, 2017). This intervention was largely based on the Mixed Classroom Educational Model and its three phases:

- **Sensitising**: Sensitising students to their own frame of reference and the assumptions underlying this.
- **Engaging**: Engaging students to interact constructively with different perspectives present in the classroom.
- **Optimising**: Optimising the learning process of each student by having them capitalise on different perspectives.

An essential element for ensuring that the Mixed Classroom Educational Model is a success is an inclusive and safe learning climate.

Did the research question need to be changed or fine-tuned?
No, it did not need to be changed or fine-tuned.

Formulating the hypotheses

Did the team have a possible explanation for the problem from the start? How were the hypotheses formulated?
Ramdas already had an explanation for the problem, based on her theoretical knowledge. However, how should the Mixed Classroom Educational Model be implemented? Which learning activities could lecturers implement to achieve the three phases of the model? Lecturers needed concrete ideas for interventions, which Ramdas had some thoughts about but which needed to be worked out.

Were the hypotheses formulated together with colleagues, students or other stakeholders? If so, did this produce new insights?
Ramdas involved her Mixed Classroom team in the search for specific learning activities to make use of diversity and create an inclusive learning climate. These are lecturers from VU Amsterdam who also work as diversity officers, and are therefore experts in diversity in education. They too had some specific ideas about how to achieve this, which resulted in new insights.

Which hypotheses were finally formulated? Did they require much fine-tuning?
The following hypotheses were formulated:

- Well-guided, in-depth meaningful discussions in education result in critical thinking, analytical skills, deeper learning, an enriched learning experience, an open attitude (to diversity), co-creation, an ability to capitalise on different perspectives, and improved communication and team working skills.
- Learning how to capitalise on different perspectives results in creativity, better problem-solving skills and improved cognitive flexibility.
- Students participate and share more if they feel safe. Ensuring anonymity using a tool such as Mentimeter can provide this safe environment.
- Students participate and share more if they feel safe. Working in buzz groups can provide this safe environment.
- Students participate and share more in a large group if they have first worked in a small group.
- Students feel safer sharing their perspectives if they have had positive experiences in their group.
- Students feel safer if previous experiences with sharing were positive.
- Students find it easier to discuss a subject if they have studied it in advance.

- Ice-breaking activities that focus on exploring similarities and/or expressing individuality increase feelings of cohesion and group identity.

As more research was carried out, these hypotheses were fine-tuned.

Testing the hypotheses

On what basis was an attempt made to confirm or refute the hypotheses? In other words, how did you find the evidence required to confirm or refute the hypotheses?
Ramdas first organised focus groups to get an idea of the experiences of students, lecturers and educational advisors with different learning activities. In these focus groups, participants were asked what worked, what didn't work, and why that was. The team probed into the answers that were given to find out the details, and this resulted in a long list of possible methods that lecturers could use in their teaching.

Based on this list, a learning pathway was developed that included the learning activities that the respondents were most positive about and that was aligned with the three model phases. For this, Ramdas made use of backward design (Wiggins & McTighe, 2005). Backward design is an educational design approach by which the designer works backwards, by first identifying the intended learning outcome and how best to assess whether it has been achieved, then determining the most appropriate learning activities, learning content, instructor roles and learning materials.

The learning pathway developed to discuss a societal issue in a lecture by applying all three phases of the Mixed Classroom model was as follows:

- Ramdas and Das start the lecture by creating a safe learning climate using the 'What's in a name?' activity, in which students split into small groups and discuss where their name comes from.
- Phase 1: Ramdas introduces a societal issue and students explore their own perspectives on the issue. How does it make me feel? Students first think about the issue on their own, then share their perspectives anonymously using Mentimeter. Because Mentimeter is anonymous, students feel safe and are not scared of giving their opinion. The Mentimeter answers are then discussed in the class, but the students are never asked who gave which answer. Instead, they are asked whether anyone wants to elaborate on an answer. In this way, the answers remain anonymous and a safe learning climate is maintained.
- The theory relating to the issue is then given: Ramdas provides background information and presents the dilemmas relating to the societal issue, as in a traditional lecture.

- Phase 2: students split into groups (buzz groups) and each group is given a card with a statement relating to the societal issue, which they have to discuss. However, before they can do this, the groups first need to agree on a group name. This gets them talking to each other at a different level to break the ice and results in some very creative names. Their discussion of the statement must relate to the theory that they were just given and to the theory that they have read to prepare for the lesson, plus their own experiences and their own knowledge.
- Phase 3: the findings of the group are discussed with the rest of the class. The idea therefore is not to give a summary, but to use the different perspectives to achieve new insights. Because each group has discussed statements relating to the same theme, further discussion can take place at the meta level.

Now that Ramdas had developed a learning pathway with activities aligned with the three phases of the Mixed Classroom model, and which the students and lecturers had had positive experiences with, the next step was to explore the academic literature. Is there evidence for the effectiveness of these learning activities? The following literature supports the design of the learning pathway:

- Well-guided, in-depth meaningful discussions in education stimulate critical thinking, analytical skills, better learning, an enriched learning experience, an open attitude (to diversity), co-creation, the ability to benefit from different perspectives and improved communication and team working skills (Freeman, Anderson & Jensen, 2007; Hockings, 2010; Zumbrunn et al., 2014).
- Learning how to capitalise on different perspectives results in creativity, better problem-solving skills and improved cognitive flexibility (Benet-Martinez, Lee & Leu, 2006; Hong et al., 2000; Nakui, Paulus & Van der Zee, 2011).
- Students participate and share more if they feel safe (Hockings, 2010). Ensuring anonymity using a tool such as Mentimeter can provide this safe learning environment (Madiseh, Al Abri & Sobhanifar, 2022).
- Students participate and share more if they feel safe (Hockings, 2010). Working in buzz groups can provide this safe environment (Caroll, 2015; Nyguist & Jubran, 2012).
- Students participate and share more in a large group if they have first worked in a small group (Sampsel, 2013).
- Students feel safer sharing their perspectives if they have had positive experiences in their group and feel that they are part of the group (Freeman et al., 2007; Rhodes & Nevill, 2004; Steele & Aronson, 1995; Zumbrunn et al., 2014).
- Students feel safer if previous experiences of sharing were positive (Freeman et al., 2007; Zumbrunn et al., 2014).
- Students find it easier to discuss a subject if they have studied it in advance (Hadjicosti et al., 2021).

- Ice-breaking activities that focus on exploring similarities and/or expressing individuality increase feelings of cohesion and group identity (Jans, Postmes & Van der Zee, 2012).

Evidence was therefore found in the academic literature for all of the hypotheses corresponding to the learning pathway.

What was the result? Was it possible to confirm or refute the hypotheses?
The hypotheses were confirmed through the focus groups and the academic literature. .

Conclusion and follow-up actions

Did the results produce a solution to the problem? If so, what was your professional final opinion?
The hypotheses and corresponding learning pathway are a solution to the problem and can be used by lecturers in their teaching practice.

How have the results been implemented in educational practice?
The Mixed Classroom model is currently being updated to align it with educational practice. For example, an additional section on online teaching was developed during the COVID-19 pandemic, and a version of the model was recently published that focuses on inclusion in blended education. Lecturers have a need for practical tools, and together with these lecturers the team is looking at what they need to be able to implement the model in teaching practice. The team is also working on a version for the sciences. It is collecting best practices and the researchers are continuing to try out activities in the classroom, to ensure that they reflect the classroom setting.

How were colleagues kept informed?
Mixed Classroom workshops are being organised to support lecturers in their implementation of the VU Mixed Classroom Educational Model and the specific learning activities. This gives lecturers the opportunity to experience the activities themselves and get an idea of their effect. VU Amsterdam is also organising reflection sessions on the Mixed Classroom in collaboration with the Network for Teaching and Learning and directly with the faculties. These sessions last an average of two hours, and in them participants can share examples from their teaching practice in a safe and structured environment. All lecturers may take part in the sessions, which provide an opportunity to share best practices and to discuss the challenges that they face.

There is also interest in the model from outside the university, and the Mixed Classroom team has given workshops and training courses for various higher education institutions.

The Mixed Classroom vision also continues to be further integrated into regular professional development activities organised by the Center for Teaching and Learning at VU Amsterdam.

What has been done to assess the effects of the change?
The learning pathway was implemented in teaching practice, and time was reserved at the end of the lesson for reflection: What did the students learn? What made the most impression? But also: how did they experience the learning activities? Did they have the feeling that they had achieved the learning outcomes? Did they experience a safe learning climate? Students wrote their answers to these questions on Post-it Notes, so that again the answers remained anonymous. It is worth noting that the students said that the lesson was very interesting, that they participated more than usual, that they learned a lot and that they would definitely like to have this kind of lesson again. The team therefore plans to carry out academic research into this learning pathway and other Mixed Classroom learning activities.

Would you like to know more about the Mixed Classroom Educational Model?
- VU-pagina Mixed Classroom
- The VU Mixed Classroom Educational Model
- Mixed Classroom integreren met blended learning
- Video Mixed Classroom

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Modelling example – Canvas Student Friendly

Interview with Charlotte Meijer



Background to the problem

Which problem does this innovation address?

The online learning management system Canvas has been used by VU Amsterdam since 2017, and it forms the heart of the VU Amsterdam virtual learning environment. Almost every lecturer and student regularly uses Canvas courses to support their teaching or learning, as it provides the basic functionalities required for education. Canvas is used to make announcements, publish documents, complete, submit and mark assignments, maintain an overview of grades, make and complete tests, and much more.

Canvas is therefore the communication platform for courses at VU Amsterdam. Lecturers are responsible for notifying students of important information, and students should be able to find everything that they need in these Canvas courses. However, students' experiences showed that this was not the case, as it was taking them a lot of time to find what they needed on Canvas, which was a waste of their time. It is for this reason that the **Canvas Student Friendly project** was started at VU Amsterdam. The project was initiated by a few students in cooperation with two educational specialists. The project focuses on the question: 'How can you use Canvas in such a way that students never miss anything and can easily find the right information?' The aim of Canvas Student Friendly is therefore that students no longer need to waste time searching for things; time that they can better use to learn.

For the Canvas Student Friendly project, the team discussed with students the most efficient and effective way to design Canvas. The result was that Canvas worked really well within the faculty. Of course, there was still room for improvement, but there were no major problems with Canvas itself. Discussions with students resulted in tips that work for every course, and these tips were put into practice in pilot projects to check that they actually make Canvas

student-friendly. The nine tips were:
- Tip 1 – Less is more
- Tip 2 – Organise modules
- Tip 3 – Syllabus as home page
- Tip 4 – Everything in one place
- Tip 5 – Introduce yourself
- Tip 6 – Be clear about communication
- Tip 7 – Publish your course in time
- Tip 8 – Reuse good courses
- Bonus Tip 9 – Know where to get help

As there were problems with the use of Canvas in several faculties, the scale of the problem was institution-wide.

How did people become aware of the problem?

Hurried migration from Blackboard to Canvas

The online learning management system Canvas was implemented at VU Amsterdam in 2017. Before then, Blackboard was used as the online learning management system. According to Ms Meijer, the migration from Blackboard to Canvas did not go smoothly. One of the reasons for this was that it took place very quickly: one day Blackboard was still being used, and the next Canvas had been implemented throughout the university, without any proper instruction for lecturers on how to use it effectively. Lecturers were pretty much thrown in at the deep end, and the users were not really considered in the system design. The result was widespread problems.

Dissatisfaction among students

The team became aware of the problem during discussions with students in which they expressed their dissatisfaction with Canvas. Ms Meijer had also experienced a lot of problems with Canvas herself during her study at VU Amsterdam. She discussed this with other students on her degree programme but also with students on other degree programmes at the university, and found that a lot of students had difficulty finding information on Canvas. For example, students said that there were a lot of menu options, that they didn't know where to find information, and that lots of documents were poorly organised. The students also said that they wasted a lot of time looking for the information they needed on Canvas.

In addition to these discussions with students, dissatisfaction was also noted through complaints to the degree programme committees and faculty student councils. The university student council was also aware of the problem.

It was therefore clear from the many complaints just how inefficient Canvas was for students, who wasted a lot of time that could instead be spent learning. This was the main reason to develop Canvas Student Friendly. Canvas Student Friendly was developed with the students' vision of how it should work in mind, and students were consulted throughout the project to give their ideas on how Canvas could be set up efficiently and effectively. Their input was used in the design of the Canvas Student Friendly tool.

Information in the academic literature

The Canvas Student Friendly project was mainly developed in response to educational practice (dissatisfaction among students). However, use was also made of the academic literature; in particular, literature on effective education. For example, an essential element of effective education is maximising the learning time (Wilkinson, 2010). If students are constantly trying to find the information about what they need to do, their learning time will not be optimal. Research by Lonn and Leasley (2009) confirms this. A study by Naveh, Tubin and Pliskin (2010) investigated the factors that contribute to the use of and satisfaction with learning management systems among students, and Alhazmi and Rahman (2012) considered which factors are responsible for such systems failing to support student learning in higher education.

The project therefore originated in educational practice but was later validated by the academic literature. It therefore concerns a qualitative action research approach.

Did the research question need to be changed or fine-tuned?

The sub-questions did not need to be changed or fine-tuned. The more Ms Meijer and her team investigated this issue, the clearer it became that there was a problem.

Formulating the hypotheses

Did the team have a possible explanation for the problem from the start? How were the hypotheses formulated?

The team did have a possible explanation for the problem from the start. Just thinking carefully about the best way to organise Canvas can already remove a lot of the problems, as students can study more effectively and it increases their motivation to prepare for lectures. This explanation was based on both insights from the literature (e.g. effective

education is achieved by maximising the learning time) and practical experiences (dissatisfaction among students concerning the use of Canvas). The hypotheses were also based on this.

Were the hypotheses formulated together with colleagues, students or other stakeholders? If so, did this produce new insights?
Two educational specialists and five students from various faculties were involved in formulating the hypotheses, which were based on practical experiences and tips from students, as well as the knowledge of the educational specialists. The practical experiences of the students were compared with the theoretical knowledge obtained from the literature (combination of practical experience and theory), resulting in well-founded hypotheses.

Which hypotheses were finally formulated? Did they require much fine-tuning?
The following hypothesis was formulated: 'The learning time, motivation and satisfaction of students is improved if their Canvas courses are more organised and consistent.' This hypothesis required little to no fine-tuning.

Testing the hypotheses

On what basis was an attempt made to confirm or refute the hypotheses? In other words, how did you find the evidence required to confirm or refute the hypotheses?
A large-scale study was developed to answer the hypothesis. The team started by organising panel discussions, in which an attempt was made to talk to as many students as possible about Canvas and to identify the precise problems that they experienced and – importantly – how to solve them. The team invited students from each faculty to the panel discussions, but their experiences of what was and wasn't good about in Canvas were similar. This made it possible for the team to produce specific examples of what did and did not work well in Canvas.

Based on this information, the team developed nine tips for designing a Canvas course, which were used to implement two pilot projects at the university. In the first project, the team designed a Canvas course for a lecturer of a first-year module, and in the second project they designed a Canvas course for a lecturer of a third-year module. This allowed them to compare students who could use a good Canvas course from the start of their degree programme and students who had previously had negative experiences with Canvas.

At the end of the two pilot projects, the team again held panel discussions with the students. Some specific questions about Canvas were also included in the course evaluation forms. The result of the panel discussions with the first-year students was that they did not really care how Canvas was organised, probably because they had no idea what it was like before. The third-year students, however, were very enthusiastic about the Canvas courses.
The conclusion of the panel discussions was that it is very important to standardise the design of the Canvas courses.

New questionnaires are currently being developed so that students can give more tips on how to design a student-friendly Canvas course.

What was the result? Was it possible to confirm or refute the hypotheses?
The result of the intervention was that the hypothesis could be confirmed. The data proved that the students' learning time was not optimal, partly due to the poor design of the Canvas courses. The students said that it was easier to find important information in the redesigned courses, so that they could prepare better for their lectures. Both the evaluation forms and the results of the panel discussions showed that students were more satisfied and no longer demotivated after using the Canvas course, which they had been before. A more organised and standardised Canvas course therefore results in more satisfied and motivated students and ultimately in more learning time.

Conclusion and follow-up actions

Did the results produce a solution to the problem? If so, what was your professional final opinion?
The results have led to a solution to the problem, although it is important that Canvas Student Friendly is implemented throughout the university. Standardising the Canvas courses means that students know what to expect and can find what they are looking for straight away. However, the implementation of Canvas Student Friendly throughout the university is proving difficult, as each lecturer/degree programme/faculty has their own ideas about how a Canvas course should be organised. This means that the tips are not always followed to the letter. The team is therefore currently working on ways to formulate the nine tips more precisely. To do this, they are recording which faculty a particular student is from, to identify whether differences can be seen between the faculties.

The team is also currently organising workshops for lecturers in which they give tips, present lots of examples and – most importantly – let the lecturers think about how they would organise Canvas. The aim of this is to achieve the broader implementation of Canvas Student

Friendly at VU Amsterdam. Another conclusion is that it is very important to involve students in the educational innovation. After all, they are the ones will use the innovation, so their perspective is essential in understanding what the best way is for them to learn.

How have the results been implemented in educational practice?
'It works and it needs to be more widely implemented.' The insights obtained in this project can also be used to design a future online learning management system. We know that standardisation is essential to achieve satisfied and motivated students who are able to make efficient use of their learning time.

How were colleagues kept informed?
Colleagues were informed about Canvas Student Friendly in various ways. For example, workshops were organised for lecturers at VU Amsterdam, and the faculty and degree programme directors were kept up to date on progress, as they are the ones who need to stimulate its use in the faculties. The team is doing its best to stay involved in the project, to make sure that Canvas Student Friendly stays on the agenda. Finally, the team is working closely with students on degree programme committees and student councils, as they continue to emphasise the importance of making Canvas student-friendly.

A bottom-up approach is applied: the team supports lecturers who request help or take action if they hear from students that something needs to be changed.

What has been done to assess the effects of the change?
The team considered the effects of the change by implementing two pilot projects in the university. In these projects, the team designed the Canvas page of a module according to the nine tips. This was then compared with the 'old data', when the Canvas course had not been designed following these nine student-friendly tips. A conclusion could then be drawn concerning the extent to which this organised design resulted in more satisfied and motivated students and more learning time.

Would you like to find out more about Canvas Student Friendly?
- sites.google.com/vu.nl/canvascafe/canvas-student-friendly (informative Canvas Student Friendly videos)
- vu.nl/nl/medewerker/didactiek/canvas-studentvriendelijk (Canvas Student Friendly – VU Amsterdam home page)

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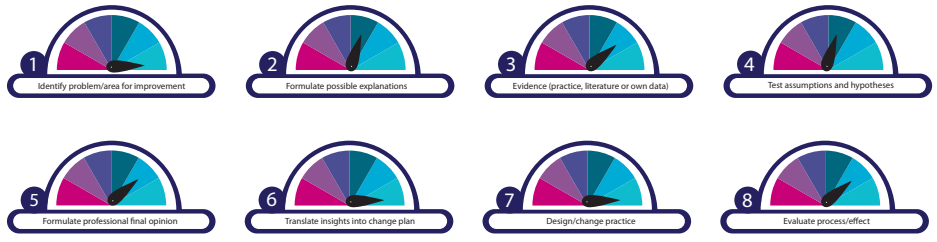
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Modelling example – Improving the 'Numeracy in Chemistry' module

Interview with Dr Jessica Zweers



Background to the problem

Which problem does this innovation address?

The problem concerns the design of the 'Numeracy in Chemistry' module at the Hanze University of Applied Sciences. Students on various degree programmes at the Institute for Life Science & Technology are required to learn numeracy in chemistry to be able to work in the lab. This is because they need abstract, core subjects such as mathematics and chemistry to be able to understand the diagnostic equipment that they will use. A certain level of numeracy is also important in other modules. Students may be admitted to these degree programmes with two different types of mathematics on their secondary school diploma ('a' for social studies or 'b' for scientific studies), which explains the difference in numeracy skills.

Some degree programmes give the Numeracy in Chemistry module at the start of the first year, but experience shows that many students struggle with this module, as can be seen in the poor average grades. One reason for this is that the module makes use of a lot of basic numeracy skills that many students lack. It is also important that students are able to apply numeracy in chemistry in the lab setting. Often, numeracy in chemistry is addressed at the same time in the curriculum in both theory and practice, but this has not proven to be a successful formula. Furthermore, because the students have difficulty with the theory, they struggle to apply the theory to practice in the lab.

Before Dr Zweers became involved in the module, students who had difficulty with numeracy in chemistry were offered extra lessons. However, Dr Zweers wanted to identify and solve the root of the problem, rather than providing extra training. She therefore discussed the issue with colleagues and students who took the module. She asked the students the following question: 'What do you need to be able to learn this module?' These discussions produced a lot of input for the redesign of the module. As a result, a preliminary module is now given before the Numeracy in Chemistry module that focuses on the required basic numeracy skills, and several didactic interventions have been implemented (incl. explicit direct instruction, constructive alignment and the scaffolding principle). The team of lecturers is still working on developing the module.

Scale of the problem: Numeracy skills are currently an issue on four of the five degree programmes at the Institute for Life Science & Technology. As students on the Chemistry and Bioinformatics programmes are more likely to have taken maths 'b' at secondary school, the problem is more common on the biology programmes, where students are more likely to have taken maths 'a'. It is therefore the students on the biology programmes who really struggle with the Numeracy in Chemistry module.

How did people become aware of the problem?

Day-to-day teaching practice

Exam results

Dr Zweers was shocked when she marked the Numeracy in Chemistry exams and saw the results, and just how poor the basic numeracy skills of many students were. She realised that it would have been better to have given mid-term tests and/or to check students' progress during the lessons. Analysis of the exam results was therefore one way in which she became aware of the problem.

Discussions with students

Not just the exam results, but discussions with students also brought the problem to light. After his first lesson, a student told her that the lesson had gone much too fast and that he hadn't understood anything. He wasn't the only one, which was also a sign that there was a problem. Dr Zweers tried to adapt the lessons to the students' needs as much as possible, and after the exam she had a long discussion with the students, in which she asked them what they needed to be able to learn the module properly. This produced several specific points for improvement, including providing step-by-step instructions and example calculations. Dr Zweers revised the lecture notes in response to this input. These experiences in day-to-day teaching practice were important reasons for the redesign of the Numeracy in Chemistry module.

Discussions with colleagues

The problem also became apparent in conversations with colleagues. The Numeracy in Chemistry module was given by several lecturers, and it became clear in evaluations that they all experienced the same problem and received similar feedback from their students. Discussions with different colleagues therefore resulted in the same conclusion, and it was clear that there was a problem with this module.

Current curriculum

The organisation of the curriculum also highlighted the problem, as the practical part of the module was scheduled at different times in different degree programmes. While in some programmes laboratory work was scheduled at the start of the year, in others it was given later. Both have their advantages and disadvantages, and this was another reason to redesign the Numeracy in Chemistry module.

The benefit of teaching theory and practice at the same time is that students can apply what they have learned straightaway in the lab. However, if they had difficulty with the theory, they will struggle with the practice too. The Numeracy in Chemistry module should therefore be scheduled early on in the curriculum as students need it throughout the programme, but the more complex aspects should be saved for later. Linking the theory and practice at a later stage, for example in the second year, has many advantages, as the students will have had their theory exam, have followed some additional modules and will be more experienced in lab work. Applying the theory in practice at this later stage therefore ensures that the students learn more, as they are, quite simply, more ready at that point.

Information in the academic literature

As well as the specific cases/critical events in day-to-day teaching practice, the redesign of the Numeracy in Chemistry module was also supported by knowledge from the academic literature.
It is worth noting that while the cause of the problem was identified in teaching practice, the choices made for the redesign of the module were based on academic literature on effective education.

In summary: all of these academic insights were translated into design requirements for the redesign of the Numeracy in Chemistry module.

Did the research question need to be changed or fine-tuned?

The research question did not need to be changed or fine-tuned.

Formulating the hypotheses

Did the team have a possible explanation for the problem from the start?
How were the hypotheses formulated?
The team did have a possible explanation for the problem from the start, as it quickly became clear that the problem was not the chemistry, although it was considered a chemistry module, but with numeracy. The students lacked the basic numeracy skills to be able to solve chemistry calculations.
The hypotheses were formulated based on practical experience (the exam results and discussions with students and colleagues).

Were the hypotheses formulated together with colleagues, students or other stake-holders? If so, did this produce new insights?
Dr Zweers was keen to maintain the dialogue with colleagues, students and other stake-holders during the redesign of the module. After all, she finds it important to stay in touch with educational practice and to implement change in this context. The hypothesis was therefore formulated following discussions with both colleagues and students on the Numeracy in Chemistry module; discussions that considered the module itself and attempted to identify the specific problems. This resulted in new insights, based on which the hypotheses were drawn up.

Which hypotheses were finally formulated? Did they require much fine-tuning?
The following hypotheses were formulated:
- The problem in the Numeracy in Chemistry module concerns the students' basic numeracy skills, not their knowledge of chemistry.
- Implementing a preliminary module to train basic numeracy skills improves the students' results (intervention 1).
- Introducing more didactic interventions in the Numeracy in Chemistry module im*proves the students' results (intervention 2).*

These hypotheses required little to no fine-tuning.

Testing the hypotheses

On what basis was an attempt made to confirm or refute the hypotheses? In other words, how did you find the evidence required to confirm or refute the hypotheses?
Data used to confirm or refute the hypotheses included the exam results for the Numeracy in Chemistry module. In addition to analysing the exam results, the hypotheses were also tested based on discussions with both students and lecturers. A combination of quantitative and qualitative data was therefore used, resulting in a wide range of insights that allowed

the hypotheses to be tested. A mixed methods approach was therefore applied that made use of both quantitative (exam results) and qualitative (informal interview/discussions with students and lecturers) analysis.

What was the result? Was it possible to confirm or refute the hypotheses?
The hypotheses were confirmed. The data from the discussions and the exam results showed that the problem in the Numeracy in Chemistry module was indeed related to a lack of basic numeracy skills. Following implementation of the two interventions, the students' exam results improved, although numeracy in chemistry remained a problem for a few students, who had perhaps reached their 'cognitive ceiling'.

Conclusion and follow-up actions

Did the results produce a solution to the problem? If so, what was your professional final opinion?
The results produced a solution to the problem. Providing a preliminary module to train students' basic numeracy skills has helped them to achieve better results, as these skills are essential for successful completion of the Numeracy in Chemistry module. The didactic interventions in the Numeracy in Chemistry module have also improved student results. Changes have therefore been made both in the module content and in its organisation, and this comprehensive approach makes the innovation more successful. Students can come onboard later on in the programme and lecturers can give much more personalised advice. This is the conclusion that Dr Zweers would like to incorporate into the development of the new curriculum: that it is better to 'spread' the module out over the year.
Dr Zweers is still working on developing the module. For example, she is investigating how to provide good online support using the scaffolding principle. One idea is that it would be better for students to complete the 'easier' calculations at home, to increase the time that can be spent in the lesson on the more difficult calculations. She is therefore working on the optimum pedagogical design of the lessons. The competence level required will remain the same, but the approach taken to achieve it will change.

Dr Zweers now knows that the problem is not in the students' knowledge of chemistry, but in (1) the students' basic numeracy skills and (2) their ability to apply these basic skills. Addressing the first problem will therefore make it possible to address the second problem, and it is with this in mind that the interventions are being implemented.

How have the results been implemented in educational practice?
Many of the results have been implemented in educational practice. Dr Zweers believes that it is not a problem if a module is difficult, but it must be designed in such a way as to give every student a reasonable chance, and this is a growth mindset (Dweck, 2016).

The first step in educational practice was to implement a new module to be taken before the Numeracy in Chemistry module. This new module focuses on basic numeracy skills. Also, the more the module is spread over the year, the more effective it is. Several didactic interventions were also implemented in the Numeracy in Chemistry module. For example, the module was redesigned to take into account that not all students have the required basic numeracy skills. The module currently makes use of the scaffolding principle, which means that students receive the support that they need to get to the required level, but are increasingly expected to perform the task independently (fading). This is also called Lev Vygotsky's 'zone of proximal development' (Zuckerman, 2007).

Another change is that different learning pathways are now provided in the module. Students who have relatively more difficulty with basic numeracy start with different calculations than other students. Each student therefore follows their own learning pathway through the module. This allows sufficient differentiation in the Numeracy in Chemistry module, to meet the different learning needs of students and therefore maximise the learning potential of each student.

Use is also being made of explicit direct instruction. This is a proven approach that helps lecturers to deliver more effective lessons and improve the success and learning outcomes of all students. The lecturer is key to the success of this approach, in which much attention is paid to high-quality teacher instruction and actively involving students in the lesson. The result is increased engagement on the part of the student and improved learning outcomes. Examples of explicit direct instruction are that the lecturer demonstrates each calculation, step-by-step, and writes out the examples in full, and checks whether every student understands the information during each phase of the lesson.

Teaching also takes place in accordance with the principles of constructive alignment (Biggs & Tang, 2011). This means that assessment tasks and learning activities are aligned with the intended learning outcomes. Following this principle, student learning is mainly driven by assessment. Dr Zweers ensures that assessment measures the extent to which students have achieved all of the learning outcomes, so that students align their learning activities with achieving those outcomes.

Note that the redesign of this module is currently a work in progress, and other didactic interventions will follow.

How were colleagues kept informed?

Various colleagues were informed. For example, discussions took place with the curriculum committee, the exam committee and the relevant lecturers. The problem was also dealt with by the lecturers as a team. Three lecturers currently teach this module, and there are some minor differences of opinion concerning the redesign of the module. Because of this, there are also differences in how each lecturer teaches their lessons: they all use the same lecture notes, but the didactic approach that they take currently differs.

What has been done to assess the effects of the change?

The effects of the change were analysed by comparing the exam results before the interventions with the exam results after the interventions. As mentioned above, Dr Zweers is still working on developing the module, and so the effects of the interventions on the exam results cannot yet be analysed.

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