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# Pe(e)rfectly Skilled:
## Underpinnings of an Online Formative Assessment Method for (Inter)active and Practice-Based Complex Skills Training in Higher Education (HE)

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### ABSTRACT

Higher education is faced with the question of how large numbers of students can be supported to learn complex skills without increasing teachers' supervision time proportionally and while preserving, or preferably improving, quality. Practicing skills only once does not work. Students need repetitive practice, feedback, and structured support to master a skill. They need to gain insight into what went well and what could be improved, so that they can further direct their attention while practicing. However, teachers cannot provide feedback after every practice session of students because their time is scarce. To solve this problem, an online formative assessment method for interactive and practice-oriented skills' training, Pe(e)rfectly Skilled, was developed. The Pe(e)rfectly Skilled method provides structured support for self-regulation, goal setting, feedback, and reflection. This method affords practicing skills repetitively, both individually and collaboratively, at students' own time, pace, and location. In this article, theoretical and practical underpinnings underlying the Pe(e) rfectly Skilled method are described.

### KEYWORDS

Complex Skills, Skills Training, Formative Assessment, Peer Feedback, Reflection, Rubrics, Video, Self-Regulation, Technology-Enhanced Learning, Design-Based Research, Distance Learning

### INTRODUCTION

Good quality complex skills training in higher education results in each students' ability to apply what they have learned in various situations, also called transfer. Transfer requires regular, timely, structured, constructive, and high-quality feedback and guidance during practice in various practice-relevant, but safe, situations (Hattie & Timperley, 2007; Shute, 2008; Van der Kleij et al., 2015; Van Merriënboer & Kirschner, 2017). Formative assessment of practice during the acquisition of skills, with feed-up (supporting students' construction of a clear mental model of the targeted skills mastery level), feedback (information on students' practice and performance of the skill mirrored against the targeted mastery level), and feed-forward (reflection on received feedback and setting

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new goals for future practice) is important (Sluijsmans et al., 2013). However, current circumstances in higher education offer only limited possibilities for supervised practice and teachers' feedback, while personalized feedback and guidance is both complex and time-consuming, considering the large number of students to be educated. Educational scalability of skills training with simultaneous maintenance of educational quality is problematic (Kasch et al, 2017). This problem especially applies to face-to-face education, but also to online, or distance, education. Moreover, existing higher education for skills mastery is probably still suboptimal and apparently a persistent problem (Peddle, 2000), as employers mentioning competence deficits or skill gaps of graduates are not uncommon internationally (Prikshat et al., 2020).

This paper describes the result of the Pe(e)rfectly Skilled design-based research project, in which the question was addressed of how students' skills acquisition processes and teachers' guidance in higher education could be simultaneously improved and become more scalable. It was partly grounded in recent research in secondary education, which showed that students' skill acquisition such as presenting orally, collaborating, and information literacy could be improved if a technology-enhanced formative assessment method with peer feedback and video-enhanced rubrics was used in a blended classroom setting (Ackermans et al., 2021a, 2021b; Rusman et al., 2019). In this method, called Viewbrics, both students and teachers received highly structured and technology-enhanced process support to formatively assess students' skills mastery levels and mirror performances during practice against video-enhanced rubrics (Rusman, et al., 2018). The method was used in practice-based project education, in a hands-on and blended (both face to face and online) setting. Technology-enhanced process support was given by means of an interactive formative assessment cycle, with various design elements such as video-enhanced rubrics and visualizations of feedback in a skills' wheel, each with specific underlying design intentions to support initial mental model formation, practice, giving and receiving (self-peer- and expert) feedback, reflection, self-regulation, and goal-setting (Rusman et al, accepted).

The current project in higher education, Pe(e)rfectly Skilled, was partly grounded on the design of, and findings from, the Viewbrics technology-enhanced formative assessment method for skills acquisition. The current project addressed the following question: *What are the theory-and practice based design characteristics of a method that contributes to increased flexible, effective, efficient, and attractive skill acquisition in higher distance education?*

The design intentions and pursued outcomes of the method were, in the context of this project, defined as follows:

- **Flexible:** Students can practice skills at their own time, location, and pace whenever it suits them best; teachers can guide and support independent of location.
- **Effective:** Students improve their skills mastery level and performance and their ability to apply their skills in various contexts and realize maximum personal growth and performance within given conditions; teachers are supported in monitoring and supporting students on the skills they need it most.
- **Efficient:** Students can practice their skills faster; teachers experience an alleviation of their guidance and supervision workload, despite large groups of students. It is time saving, scalable, as paperless as possible, usable, useful, and user-friendly.
- **Attractive:** Students and teachers are motivated to practice, support, and supervise the acquisition of skills in a more meaningful manner and enjoy working with the proposed solution.

In this paper we describe both the theoretical as well as the practical underpinnings of the Pe(e) rfectly Skilled method, related to the design intentions above. Furthermore, we provide an overview of the main design elements of the method and their underlying design rationales and intentions.

## THEORETICAL AND PRACTICAL APPROACH AND UNDERPINNINGS

The Pe(e)rfectly Skilled method was designed and developed based on three main sources of theoretical and practical input and the pursued design outcomes specified in the previous section. First, acquired results and experiences of the Viewbrics project (Ackermans et al 2021a, 2021b, in press; Rusman et al, 2018, 2019), a technology-enhanced method for complex skills acquisition in secondary education, were brought in at the start of the project. Second, a cyclic, participatory research and design (R&D) approach was chosen, in which teachers from two different disciplines in higher education, law and psychology, educational technologists and researchers and various systems design experts collaborated in a core development team. This stakeholder design team met a minimum of once every two weeks during the design and development phase to discuss the design in an iterative design cycle. This team was supplemented with additional experts in areas such as scriptwriting, multimedia, and interface design when needed. Third, the design was informed by theory to develop an evidence-informed design that most probably contributed to increased flexible, efficient, effective, and attractive skills acquisition in higher education. In this section, we mainly focus on theory related to improving the effectiveness of supporting students' skills acquisition. In the subsequent section, we further clarify the relation between the Pe(e)rfectly skilled method, specific evidence-informed design elements within it, and their underlying design intentions.

### Acquisition of Complex Skills

To master complex skills, it is necessary to practice and apply them actively, regularly and, if possible, frequently. Complex skills consist of constituent subskills which require high cognitive effort and concentration to integrate (Kirschner & Van Merriënboer, 2008; Van Merriënboer & Kirschner, 2017; Voogt & Pareja-Roblin, 2012). Complex generic skills are not specific for a domain, occupation, or type of task, but important for all kinds of work, education, and life in general. These skills are applicable in a broad range of situations and many subject domains (Bowman, 2010). Practicing complex skills only once will not lead to mastery of skills and performance in practice. Students need regular practice, guidance and support, structure and high quality, timely and constructive feedback to gain insight into what went well and where improvement is still possible. This helps students to focus their attention while further practicing. However, teacher time is scarce, as they have large student groups to support; therefore, frequent and personalized feedback can often not be realized in practice. Students also need repetition and meaningful, different whole task contexts to apply their skills, also called variability of practice (Kirschner & Van Merriënboer, 2008; Van Merriënboer & Kirschner, 2017) in order to enhance transfer of the application of skills to new settings. Furthermore, they need good and bad examples of skills execution and associated visible behavior (Van Gog et al, 2014; Van Gog & Rummel, 2010) in order to form a mental model of what task performance level is expected from them. They need support to form this mental model of the whole skill, its constituent subskills, and the performance level(s) that they could or should reach when practicing.

### Formative Assessment: Mirroring and Guiding Oneself Towards Complex Skills Mastery

Formative assessment is a continuing cyclic process of feed-up, feedback, and feedforward. Information on learners' performances is continuously gathered, mirrored against a set of predefined criteria or good practices, and is subsequently used to improve and promote an individual's learning, rather than merely serve as a final formal summary of their achievements (Sluijsmans, et al., 2013). When learners become aware of the skill mastery level they are striving for, through the formation of a mental model based on various information sources (feed up), they can mirror their own performance against this benchmark. Other sources (e.g. system, peers, experts) can provide learners with feedback

on their performance, compared to this benchmark. Based on additional advice, such as tips and tops (feedforward), and learners' reflection on their own performance, new learning objectives can be formulated. This allows learners to focus on deficient subskills (Ackermans et al., 2021; Hattie & Timperley, 2007; Rusman et al., 2019) while practicing their skills. When learners acquire insight in their performance compared to the targeted mastery level of a complex skill, through mental model formation, they can better self-regulate and monitor their learning activities and communicate with teachers (Panadero & Jonsson, 2013; Schildkamp et al., 2014). Providing timely feedback during formative assessment is one of the most effective ways to support learning processes (Hattie & Timperley, 2007). Two main processes, with various subprocesses, are key to formative assessment: 1) self-regulation and 2) feedback.

### *Self-Regulation Through Initial Goal Setting, Monitoring, and Reflection*

Self-regulation implies an active role of learners in their own learning process, and it assumes that learners therefore need a certain level of autonomy to guide that process (Zimmerman, 2000, 2002). It is an active, constructive process in which learners, guided by the learning context, use self-regulation skills to achieve learning goals. Self-regulation skills are cognitive, motivational, and metacognitive skills with which learners direct their learning (Pintrich, 2004; Zimmerman, 2002). According to the Zimmerman (2002) review of six commonly adopted and applied models for self-regulation, skills are deployed in a cyclical process consisting of three phases: 1) a planning phase (forethought phase), 2) an implementation phase (performance phase), and 3) a reflection phase. In the forethought phase, learners analyze a task and motivate themselves to perform it. They set goals at the task or process level and schedule them on a timeline. Learners reflect on what they already know using a standard or through task analysis and motivate themselves by assessing whether they are able to perform the task and whether they consider the task as relevant. In the implementation phase, learners monitor their progress against their predetermined goal and focus and adapt their learning strategies (i.e., analyzing, structuring, process monitoring) to achieve these goals. During task execution, they monitor their progress towards goal achievement and adjust their behaviour.

In the reflection phase, learners evaluate their performance both in terms of the learning process as well as its outcomes. Reflection is a goal-directed activity, in which a person consciously looks back at a personal experience in a situation (Shute, 2008). A gap between what happened in this situation and what ideally should happen is identified. Learners assess whether they achieved the intended learning objective(s), compare performance with previous results, the performance of others, or standardized benchmarks such as rubrics. Thereby they gain insights into how the discrepancy between the actual and the ideal situation can be reduced, so that these insights can be used in comparable future practice situations. Finally, they think about how to further direct their learning and use the obtained information to strive for and achieve new learning goals. This aligns with the feed-up and feed-forward concepts within the concept of formative assessment.

### *Feedback: Self, Peer, and Expert Perspectives on Learners' Performances*

Feedback is information provided by an agent (e.g., teacher, peer, book, system, parent, self, experience) regarding aspects of a learner's performance. Feedback is therefore a consequence of performance (Hattie & Timperley, 2007). Looking from a system analysis perspective at the concrete and practical process of feedback, feedback therefore always requires a performance goal or objective, a prompt (e.g., a task or a question), an action or performance of a learner in response to this prompt, a comparison of this performance against a qualitative standard or benchmark (e.g., criteria, examples) and information acquired through this comparison (e.g., this went well, this could still be improved) that provides a learner with insights into how to adapt and direct their learning activities. Feedback should not only tell how a learner is doing towards a specific goal, standard, or benchmark criterion, but should additionally provide information about what is needed in order to meet it. To gain insight into personal performance and to direct learning, feedback is one of the most powerful mechanisms

to promote learning. It helps in "reducing the discrepancies between current understandings and performance and a desired goal" (p.86, Hattie & Timperley, 2007).

It is important that learners are guided and supported through these processes, through human (e.g., teacher/expert, peers) or technological support. This was the point of departure for the design and development of the Pe(e)rfectly Skilled method. In the next section, the Pe(e)rfectly Skilled method and its functionality is first described in a generic manner. In this description certain design elements are highlighted through the use of ***bold italics***. Additionally, the underlying design intentions and design rationales, linked to relevant theory, practice, and pursued design outcomes, are elaborated upon for each design element. An overview of all design elements, their design intentions, and underlying rationales in relation to the pursued outcomes are described in Table 1.

## UNRAVELING THE PE(E)RFECTLY SKILLED METHOD: ONLINE STUDENT PROCESS SUPPORT AND DESIGN ELEMENTS TO SUPPORT COMPLEX SKILLS ACQUISITION

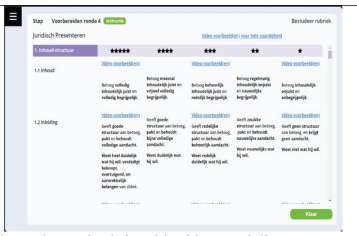
The Pe(e)rfectly Skilled (Pe(e)rfect Vaardig in Dutch) method is an interactive, practice-oriented online formative assessment method that supports practicing skills, goal setting, self-regulation, giving and receiving (self-teacher and peer) feedback and reflection on a student's performances. Students are supported to practice their skills in a meaningful, structured, systematic, and repetitive manner in simulated practice, and through the execution of a ***task***. The online method provides process support and affordances for goal setting, practice, feedback, reflection, and self-regulation through a ***technology-enhanced online formative assessment cycle***. Students are guided to go independently through this complete formative assessment cycle in five steps, in which they determine themselves where they are going, how they are doing (compared to a benchmark), and where to go next. They are supported online during this process. This cycle allows students to practice their skills, both individually and in a small peer group, at their own time and place. Students are supported to form a mental model of what skills mastery level is expected of them through the availability of ***video-enhanced analytic rubrics*** and ***video-modeling examples,*** by using the rubrics on a ***standard video-modeling example*** and by comparing their feedback with the feedback of an expert. A video-enhanced rubric is an integration of a video-modeling example with example situations and role models, and an analytic rubric (Ackermans et al., 2021a, 2021b). A video-modeling example is an (good or bad) example of task execution and associated behavior that can support observational learning and mental model formation to acquire skills. Looking at positive effects of video-modeling examples, Van Gog et al. (2014) and Van Gog and Rummel (2010) found an increased performance of task execution when a video-modeling example of an expert was shown, and De Grez et al. (2014) found comparable results while learning presentation skills. Video-modeling examples can capture know-how (procedural) knowledge and may also include know-why (strategic/decisive) knowledge (Westera, 2012), which can be used during practicing a skill as well as while providing feedback. Furthermore, students assess themselves and each other, in addition to teacher feedback, by providing feedback through applying these video-enhanced ***analytic assessment rubrics*** on ***video recordings of their own and others' practice sessions***. An analytic assessment rubric describes skill mastery levels in text, by means of a set of performance indicators for constituent subskills (Andrade & Du, 2005). Such indicators specify aspects of variation in the complexity of a skill (e.g., presenting for a small, homogeneous group compared to a more complex presentation for a large heterogeneous group), constituent subskills, and related performance levels (Arter & Chappuis, 2006; Rusman & Dirkx, 2017). A rubric defines the features of work that are considered to determine quality. It is a mechanism for judging the quality of a student's performance on a task (adapted from Arter & Chappuis, 2006). It is an instrument that can be used to foster and support feedback and reflection when practicing skills. A ***comparison of self-peer-and-teacher feedback*** is summarized in clear visualizations of students' performance in a ***feedback and reflection*** (in this case ***skill***s) ***wheel***, indicating what is going well and what could

be improved. Moreover, students formulate ***tips and tops*** for peers, to improve their performance. These tips and tops are summarized in a ***feedback report***. Students go through a complete feedback and reflection cycle themselves, with as an end point and a new beginning the ***definition of learning objectives*** for the next round of practice. Thus, students can practice and train their skills at home, when it suits them, and as often as they want. Teachers keep track of personal progress and growth of students through a ***dashboard*** with ***student and group progress visualizations.***

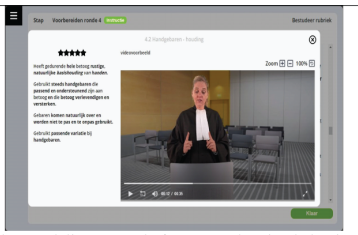
The backbone of the method is the formative assessment cycle that students can independently and autonomously go through. This cycle contains five steps, with several conditions to proceed to the next step in the standard or default implementation. However, this ***workflow*** and the ***workflow dependencies*** can be tailored to specific situations, through an authoring environment. The default formative assessment cycle contains the following five steps, which contain ***instructions*** and are technically supported online through a specific workflow. Below, we describe these steps and present the major interfaces associated with this formative assessment process, from a student's perspective.

**Step 1 - Prepare:** Students look at the instruction, the video-enhanced rubrics, and the complete video-modeling examples to form a mental model of the complex skill and the expected performance level. To construct the rubric (Figure 1a), skills were analyzed, decomposed and placed in a skills hierarchy with skill clusters, subskills, and various performance levels and performance level descriptions for each subskill. In a video-enhanced rubric, video-modeling examples are integrated with the performance level descriptions of each subskill (Figure 1b). In this preparation step,

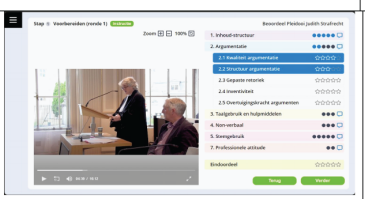
**Figure 1. Step 1 - Prepare: Overview with Selection of Functionality and Interfaces**



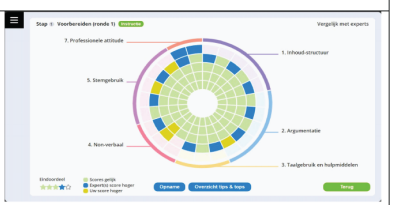
a. Video-enhanced rubric with video-modeling examples (accessible through blue links) is provided at three performance levels for each subskill within a skill cluster.



b. Video-modeling example fragment, showing behavior associated with the highest performance level description (indicated by stars) and integrated with the analytic rubric textual description.



c. Students assess a standard video-modeling example with the analytic assessment rubric. From the overview with skills clusters and subskills with various performance levels to the right of the screen, students can 'click' on each subskill and go to their description (see 1a).



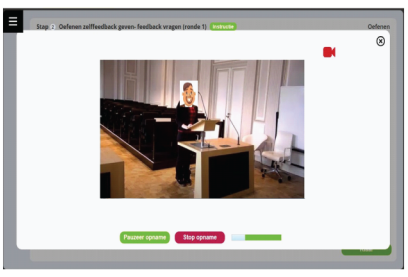
d. A comparison of student feedback with expert feedback is visualized in the skills wheel. Each skill cluster has its own color and label, indicated on the border of the circle. Each 'spoke' of the wheel represents a subskill. Where experts scored higher than students, the difference is marked blue, when- lower, yellow. When their score was equal, it is colored green.

students also provide feedback on a standard video modeling example (Figure 1c) and compare their feedback on this example with expert feedback to form a mental model and to practice their own feedback skills. They receive feedback through a visualization of this comparison, called the skills wheel, where their performance is automatically compared with an expert assessment and differences are visualized (Figure 1d). Thus, students can see where they were more strict or less strict with their assessment and feedback compared to experts. In the default setting, students must finish step 1 before they can proceed to step 2.

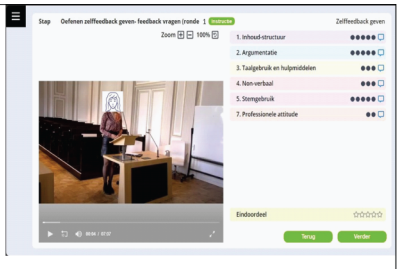
**Step 2 - Practice:** In this step, students practice, record their practice session(s) (Figure 2a) and analyze their performances through self-assessment, using the video-enhanced analytic scoring rubrics (Figure 2b). They can practice as often as they want until they are satisfied with their performance. Then they share this performance with their peers and teacher(s) and ask for feedback. In the default setting, students must finish step 2 (and its substeps: practice, self-assess, share recording with others), with at least one self-assessment and a request for feedback to peers/teachers, before they can proceed to step 3.

**Step 3 - Provide peer feedback:** In this step, students provide each other with peer feedback. Students are divided into small peer groups when they start using the method and provide their feedback within this group. The teacher can also provide feedback, although this is not necessary. Students use the video-enhanced analytic scoring rubric to assess each other's performances (Figure 3a). While assessing, they can also watch and compare against the

**Figure 2. Step 2 - Practice: Overview with Selection of Functionality and Interfaces**

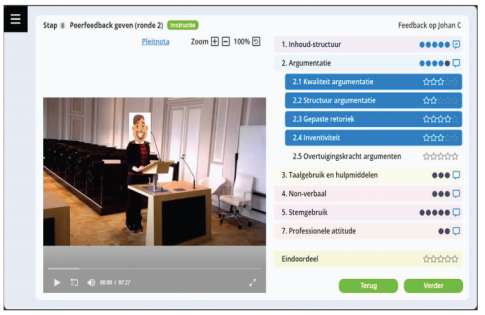



a. Students practice a skill and record their performance, either through uploading recordings from another device or directly online within the method via their Webcam. Other types of performances in various formats (e.g., pdf, ppt) can be uploaded. In the online setting, the method provides feedback while students practice their session compared to a set standard length. This is done by the progress indicator bar. Green is on pace, orange means to speed up, and red means the set time standard has been crossed. The length standard can be set variably.

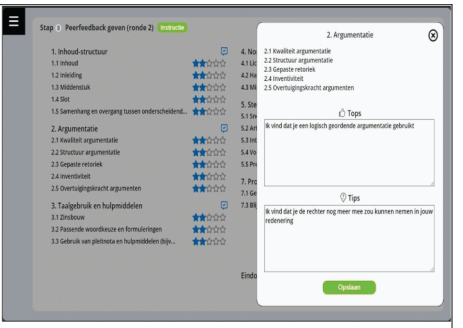



b. Students self-assess and reflect on their own performance with the help of the video-enhanced analytic scoring rubric. The scoring rubric provides a quality standard as a reference framework, so that students can mirror and compare their performance themselves.

**Figure 3. Step 3 - Provide Peer Feedback: Overview with Selection of Functionality and Interfaces**




a. Students provide each other with peer feedback with the help of the video-enhanced rubrics. They can easily see what subskills they have already assessed (blue dots) within a specific skill cluster, and which still need to be assessed (black dots). They can also provide tips and tops by clicking on the blue text balloons.

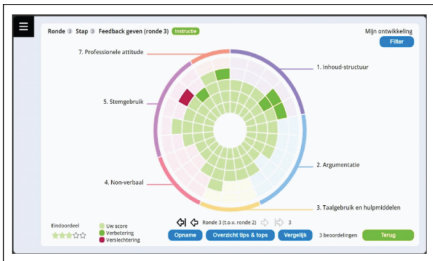



b. Students provide each other with tips and tops on the level of each skill cluster. To remind students of the subskills within this cluster to help them formulate feedback, these subskills are repeated below the label of the cluster. Students also have an overview of the subskills they already rated with the rubric and from this overview can easily alter and elaborate their feedback further.

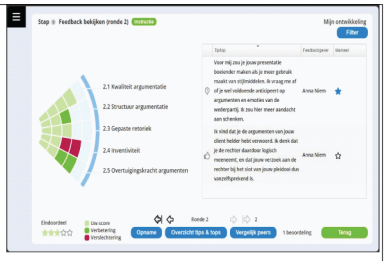
modeling examples provided for each subskill. Students are instructed on how to provide each other with high quality feedback and feedback rules. In addition to the peer assessment with the rubrics, students provide each other with tops and tips on their performances and ideas on how peers could improve them further: what went already well and what and how performances can still be improved (Figure 3b). Students can choose to send their feedback directly to an individual peer or can assess and collect their assessments of several peers before they send them out. This last option allows some adaptation of earlier peer assessments, based on the increased peer assessment experience of students. In the default setting, all students must finish step 3 before they can look at their own feedback within their peer group in step 4.

**Step 4 - Analyze feedback:** In this step students look at and analyze the summarized feedback of their peers in the feedback group, and possibly their teacher. This feedback is automatically summarized and displayed in a skills wheel. If students had a previous session of practice, the difference between their current performance and their previous one is displayed (Figure 4a). Students can study the feedback for each skill cluster in detail by zooming in on this cluster (Figure 4b) and can also filter feedback, so that it is displayed per actor. Furthermore, all tips and tops given by various actors (peers, teachers) are summarized in a feedback report. Students can mark the tips and tops given in the feedback report (Figure 4c) if they

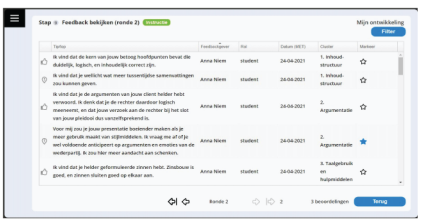
**Figure 4. Step 4 - Analyze Feedback: Overview with Selection of Functionality and Interfaces**



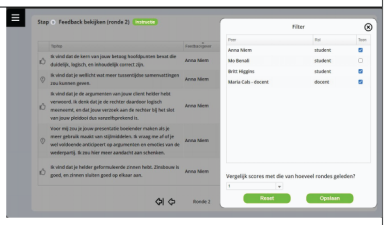

a. Feedback is automatically summarized and displayed in the skills wheel and compared to previous performance. Students can see where performance of a subskill can still be improved as an indent in the wheel. Each spoke represents a subskill, and each block in a spoke represents a performance level. If performance improved, a subskill becomes bright green; when it faltered it turns red. Students can filter feedback per person.




b. Students can look at the feedback per skills cluster more specifically. This student improved on 2.2. and 2.5, but performance faltered on 2.4. when compared to their previous practice session. They can still improve on all subskills (as none of them reached the outer part of the wheel), however most importantly on 2.4, and then 2.2 and 2.3.




c. Students receive a summary of all tips and tops, with information on how they can further improve their performance, provided by peers, and possibly teachers. They can mark specific tips and tops. These tips and tops become visible and available in step 5, when students define learning objectives for their future practice sessions.



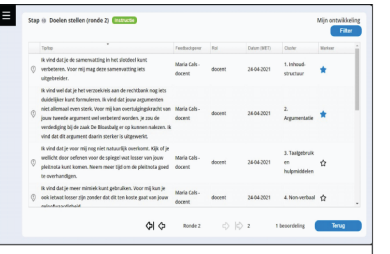

d. Students can filter both tips and tops as well as the rubric scores (see Figure 4a), so that feedback given becomes visible per actor.

consider it particularly worthwhile to consider for future practice. They can also filter this feedback per person (Figure 4d).

**Step 5 - Set goals:** Students formulate new goals for future practice, based on the self-peer and expert assessment information in the method and the goals they specified after their previous practice session (Figure 5a). The assessment information is available through the skills wheel and through the marked tips and tops in the feedback report (Figure 5b).

**Figure 5. Step 5 - Set Goals**


a. Students formulate goals for their future practice sessions, based on the feedback visualized in the skills wheel and their marked tips and tops within the feedback report. While formulating these new goals, they have the detailed information in the complete skills wheel available by clicking on the miniature wheel. They also see the goals they formulated in their previous practice round, to compare with their current performance.




b. Students can also jump back to the feedback report to see whether they, upon consideration, want to mark additional tips and tops. These become available within the overview in the right part of Figure 5a.

In the formative assessment process description and associated online workflow described above, several design elements are highlighted. In Table 1 we elaborate upon the underlying design intentions and rationales of each element, in relation to both theoretical grounding as well as pursued outcome (increased flexibility, effectiveness, efficiency and attractiveness of skills education).

**Table 1. Overview of the Design Elements of Pe(e)rfectly Skilled and Their Design Intentions and Rationales**

| Design Element | Design Intentions and Rationales in Relation to Theory and Pursued Outcomes |
|---|---|
| Online and technology enhanced formative assessment cycle | • Supports practicing skills independently and repetitively, both individually and collaboratively, at students' own time and place (and at their own pace, within certain boundaries), as often as they want. This increases students' and teachers' flexibility to learn and supervise, (e.g., at home), in the moments that suit them best. Structured, repetitive and regular practice is expected to positively affect learning effectiveness. The method aims to ensure that students can practice independently and receive high quality feedback more frequently, so that they can work goal-oriented and focus their attention on specific subskills of their skill development (effectiveness), without increasing teachers' workload (efficiency).<br>• Stimulates and systematically supports self-regulation with goal setting, monitoring and reflection, and feedback processes, through a stepwise and structured approach. Students are guided online through a complete formative assessment cycle, namely forethought, implementation, and reflection, but determine for themselves where they are going, how they are doing, and where to go next. This intends to positively affect learning effectiveness.<br>• Prevents the use of piles of paper, saves time by automatic comparison and display of assessments in clear and informative visualizations (wheel) and allows flexible implementation by altering the number of steps, in addition to place independency of practice. Thus, the method intends to enhance efficiency.<br>• Reduces teachers' workload through use of peer feedback, and makes self-regulated skills acquisition, practice, and personal feedback possible for both individuals and groups, even with large groups of students.<br>• Teachers have access to a dashboard with students' skill development and progress visualizations on both individual and group level. Thus, teachers can focus their attention on problematic issues and specific students' needs. Products, performance, and progress of students are automatically tracked and displayed. |

*continued on following page*

**Table 1. Continued**

| Design Element | Design Intentions and Rationales in Relation to Theory and Pursued Outcomes |
|---|---|
| Analytic assessment rubric | • Makes performance level expectations explicit through specific criteria and performance level indicators. Thus, it provides a performance standard that students can use to form a mental model of the expected and strived-for final performance before they start practicing (feed-up).<br>• Supports mirroring and reflecting upon their own and others' performance while practicing.<br>• Supports provision of informative and structured (self, peer, and teacher) feedback.<br>• Supports defining new learning objectives after reflection upon performance.<br>• Supports uniform communication via rubric scores between learners, teachers, and other experts about requirements and performance expectations. Thus, it also helps to formulate tips and tops on which aspects and how learners can further improve their performance (feed-forward). This helps to specify useful and constructive feedback and enables learners to pay extra attention to specific aspects that they didn't yet master during practice, thus contributing to learning effectiveness.<br>• Supports monitoring learners' progress and adjust the teaching-learning process accordingly (feed-forward). |
| Video-enhanced rubric | • Envisages and displays the targeted performance level of skills and associated behavior in video fragments, linked to the performance indicators in the textual rubric. Provides procedural, contextual, dynamic, time-specific, and tacit information on the expected performance that is difficult to describe but becomes apparent and visible through the integration of fragments with video modeling examples and textual performance indicators.<br>• Provides role models and examples and technology-enhanced support for goal setting and self, peer, expert feedback, and reflection. These affordances allow students to form a mental model, to self-evaluate their performance, and to provide structured peer feedback.<br>• Fosters observational learning of good and bad video modeling examples (e.g., role models, task execution and example situations) and allows for analysis, as they are combined with textual performance indicators, thus supporting mental model formation of the intended level of performance and proficiency. |
| Video-modeling example | • Envisages complete good or bad examples of role models' performance and associated behavior when executing a task, thus providing the opportunity to form a mental model on aspects of good and bad performance when executing a certain task. |
| Standard video-modeling example | • A video-modeling example was used as a reference case for analysis and practice with the use of video-enhanced analytic assessment rubrics and providing feedback. This standard example was also assessed by experts, thus allowing a comparison of the feedback students provided with this expert assessment, supporting students to learn how to assess their peers and provide them with clear, relevant, and more easily understandable high-quality feedback. |
| Expert assessment | • Assessment and feedback provided by experts on a standard video-modeling example. |
| Video recordings of practice sessions | • Video recordings supporting reviewing, analysis, and reflection of own practice sessions. Recordings can be easily uploaded or recorded while practicing and be deleted or replaced when deemed unnecessary by students. When recording live, students see an indication of whether or not they will finish their performance within time limits. |
| Tops and tips | • Provides information on things that went well and things that can still be improved on, provided by peers and/or teachers. |
| Marking/ starring feedback | • Supports selection of specific tips and tops that students find particularly relevant and useful, to consider when specifying learning objectives for future practice sessions. |
| Feedback and reflection wheel (here 'skills' wheel) | • Summarizes feedback on a student's performance, provided within a peer group and teachers, automatically through informative visualizations displaying the mean performance level assessment. Thus, provides clear and quick insight into what aspects of this performance went well and what can still be improved. |
| Feedback report | • Generates an overview of all provided tips and tops provided within a peer group automatically, with the ability to mark specific feedback. |
| Task | • Provides students with a relevant task and context, as a prompt to practice, learn, and teach complex skills in a more meaningful way (more attractive). |
| Instruction and guidance | • Provides students with explanations of the various steps and relevant instruction to execute learning activities and steps within the formative assessment cycle. Students are, for example, provided with clear instructions on how to provide constructive and qualitative feedback and how to record their own practice sessions. |
| Online workflow | • Supports and guides students and teachers through all necessary and relevant steps for learning and monitoring the acquisition of complex skills online. The workflow is interwoven with the formative assessment cycle and the interface. Students must finish specific steps before they can proceed, and thus go through all optimal process steps to train their skills. |
| Workflow dependency | • Allows for controlling both students' and teachers' activities, by only allowing continuation of learning activities when specific conditions (e.g., completion of a task or step) are met. |

## CONCLUSION

The Pe(e)rfectly skilled method is designed based on learning and instruction theory and input from stakeholders in higher education to impact the flexibility, effectiveness, efficiency, and attractiveness of skills acquisition. Our expectation is that this online formative assessment method to train skills could be used for various types of complex skills that are relevant in different domains, as long as

they can be translated to an analytic assessment rubric and when students' performance(s) can be made digitally explicit (e.g., through a video-recording assignment). The method can contribute to better quality skills education, for larger groups of students, by supporting more opportunities for practice and feedback. The expectation is that this can be achieved without an increase or possibly even a reduction in teachers' workload. Three pilot studies in two domains (law and psychology) at two universities (over 400 students) will be conducted to evaluate whether the method is appropriate for skills training in higher education, by making it more flexible, effective, efficient, and attractive in practice. The generic applicability of the method will be explored. In these pilots, we will also vary the feedback formats (with/without a teacher) to see whether it would also be possible to use the method without teacher feedback, thus further reducing teachers' workload. We expect that students will still become more skilled and that they will be as well satisfied with peer feedback as with teacher feedback. Therefore, we expect that the P(e)erfectly Skilled method offers several opportunities to organize skills education more flexibly, efficiently (reduction of teachers' time), effectively (supporting crucial learning processes for skills acquisition and mastery), and attractively online, for large groups of students in higher education. Cross-curricular, cross-faculty, institution-wide, or cross-institutional skills education of different types of skills could eventually be supported with this method. Herein, a (national) library with video-enhanced rubrics as open educational resources and peer groups 'across' higher educational institutes could be imagined, also offering an innovative educational (and new organizational) approach to training skills in higher education.

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## REFERENCES

Ackermans, K., Rusman, E., Nadolski, R. J., Brand-Gruwel, S., & Specht, M. (2021a). Video-enhanced or textual rubrics: Does the viewbrics' formative assessment methodology support the mastery of complex (21st century) skills? *Journal of Computer Assisted Learning*, *37*(3), 810–824. doi:10.1111/jcal.12525

Ackermans, K., Rusman, E., Nadolski, R. J., Specht, M., & Brand-Gruwel, S. (2021b). Feedback is a gift: Do video-enhanced rubrics result in providing better peer feedback than textual rubrics? *Practical Assessment, Research & Evaluation*, *26*(1).

Andrade, H., & Du, Y. (2005). Student perspectives on rubric-referenced assessment. *Practical Assessment, Research & Evaluation*, *10*(3), 1–11.

Arter, J. A., & Chappuis, J. (2006). *Creating & recognizing quality rubrics*. Pearson.

Bowman, K. (2010). Background paper for the AQF council on generic skills. Academic Press.

De Grez, L., Valcke, M., & Roozen, I. (2014a). The differential impact of observational learning and practice-based learning on the development of oral presentation skills in higher education. *Higher Education Research & Development*, *33*(2), 256–271. doi:10.1080/07294360.2013.832155

Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of Educational Research*, *77*(1), 81–112. doi:10.3102/003465430298487

Kasch, J., van Rosmalen, P., & Kalz, M. (2017). A framework towards educational scalability of open online courses. *Journal of Universal Computer Science*, *23*(9), 845–867.

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

Kirschner, P. A., & Van Merriënboer, J. J. G. (2008). Ten steps to complex learning: A new approach to instruction and instructional design. In T. L. Good (Ed.), 21st Century Education: A Reference Handbook (pp. 244-253). Sage. doi:10.4135/9781412964012.n26

Panadero, E., & Jönsson, A. (2013). The Use of Scoring Rubrics for Formative Assessment Purposes Revisited: A Review. *Educational Research Review*, *9*, 129–144. doi:10.1016/j.edurev.2013.01.002

Peddle, M. J. (2000). Frustration at the factory: Employer perceptions of workforce deficiencies and training needs. *The Journal of Regional Analysis & Policy*, *30*(1).

Pintrich, P. R. (2004). A conceptual framework for assessing motivation and self-regulated learning in college students. *Educational Psychology Review*, *16*(4), 385–407. doi:10.1007/s10648-004-0006-x

Prikshat, V., Montague, A., Connell, J., & Burgess, J. (2020). Australian graduates' work readiness: Deficiencies, causes and potential solutions. *Higher Education, Skills, and Work-Based Learning*, *10*(2), 369–386. doi:10.1108/HESWBL-02-2019-0025

Rusman, E., & Dirkx, K. (2017). Developing rubrics to assess complex generic skills in the classroom: How to distinguish skills' mastery levels? *Practical Assessment, Research & Evaluation*, *22*(12). http://dspace.ou.nl/handle/1820/8802

E. Rusman, R. Nadolski, & K. Ackermans (Eds.). (2018). Students' and teachers' perceptions of the usability and usefulness of the first viewbrics-prototype: a methodology and online tool to formatively assess complex generic skills with video-enhanced rubrics (VER) in Dutch secondary education. *Proceedings of the 21st International Conference on Technology Enhanced Assessment (TEA)*.

Rusman, E., Nadolski, R.J., Ackermans, K. (2019). *Viewbrics, 'spiegel' je vaardig: Vakoverstijgende vaardigheden aanleren in het voortgezet onderwijs via een (online) formatieve evaluatie-methode met (video-verrijkte) rubrieken. Eindrapportage*. NRO: 405-15-550.

Rusman, E., Nadolski, R.J., & Ackermans, K. (in press). *Viewbrics: A technology-enhanced formative assessment method to mirror and master complex skills with video-enhanced rubrics and peer feedback in secondary education*. Academic Press.

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *The American Psychologist*, *55*(1), 68–78. doi:10.1037/0003-066X.55.1.68 PMID:11392867

Schildkamp, K., Heitink, M. C., van der Kleij, F., Hoogland, I., Dijkstra, A. M., Kippers, W. B., & Veldkamp, B. P. (2014). *Voorwaarden voor effectieve formatieve toetsing: een praktische review*. Universiteit Twente.

Shute, V. J. (2008). Focus on formative feedback. *Review of Educational Research*, *78*(1), 153–189. doi:10.3102/0034654307313795

Sluijsmans, D., Joosten-ten Brinke, D., & Van der Vleuten, C. (2013). *Toetsen met leerwaarde* [Assessments with value for learning]. NWO.

Van der Kleij, F. M., Feskens, R. C. W., & Eggen, T. J. H. M. (2015). Effects of feedback in a computer-based learning environment on students' learning outcomes: A meta-analysis. *Review of Educational Research*, *85*(4), 475–511. doi:10.3102/0034654314564881

Van Gog, T., & Rummel, N. (2010). Example-based learning: Integrating cognitive and social-cognitive research perspectives. *Educational Psychology Review*, *22*(2), 155–174. doi:10.1007/s10648-010-9134-7

Van Gog, T., Verveer, I., & Verveer, L. (2014). Learning from video modeling examples: Effects of seeing the human model's face. *Computers & Education*, *72*, 323–327. doi:10.1016/j.compedu.2013.12.004

Van Merriënboer, J. J. G., & Kirschner, P. A. (2017). *Ten steps to complex learning* (3rd ed.). Lawrence Erlbaum. doi:10.4324/9781315113210

Voogt, J., & Pareja-Roblin, N. (2012). A comparative analysis of international frameworks for 21st century competences: Implications for national curriculum policies. *Journal of Curriculum Studies*, *44*(3), 299–321. doi:10.1080/00220272.2012.668938

Westera, W. (2012). On the changing nature of learning context: Anticipating the virtual extensions of the world. *Journal of Educational Technology & Society*, *14*(2), 201–212.

Zimmerman, B. J. (2000). Attaining self-regulation: A social cognitive perspective. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), *Handbook of Self-Regulation: Theory, Research, and Applications* (pp. 13–39). Academic Press. doi:10.1016/B978-012109890-2/50031-7

Zimmerman, B. J. (2002). Becoming a self-regulated learner: An overview. *Theory into Practice*, *41*(2), 64–70. doi:10.1207/s15430421tip4102_2