A First Step Towards Synthesizing Rubrics and Video for the Formative Assessment of Complex Skills

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Abstract. For learners, it can be difficult to imagine how to perform a complex skill from textual information found in a text-based analytic rubric. In this paper we identify three deficiencies of the text-based analytic rubric for the formative assessment of complex skills. We propose to address the text-based analytic rubric's deficiencies by adding video modeling examples. With the resulting Video Enhanced Rubric we aim to improve the formative assessment of complex skills by fostering learner's mental model development, feedback quality and complex skill mastery.

Keywords: Video · Rubrics · (Formative) assessment · Complex skills · Mental models

1 Introduction

A text-based analytic rubric can be an effective instrument for the formative assessment of complex skills, providing a detailed description of each level of complex skill mastery. This detailed description provides structured and transparent communication of the assessment criteria, providing a uniform assessment method that fosters insight into complex skills acquisition and fosters learning [1]. Apart from being an effective instrument, the rubric is an instrument that can be implemented to address the lack of explicit, substantial and systematic integration of complex skills in the Dutch curriculum [2, 3].

This paper proposes that implementing a rubric for the specific purpose of formatively assessing complex skills presents several deficiencies. For instance, it can be hard for learners to form a rich mental model of a complex skill from a rubric alone. To understand the deficiencies of a rubric when applied for this specific purpose, we need to understand the characteristics of the complex skills we wish to foster. For this paper, the term complex skill is used for the complex skills of presentation, collaboration and information literacy. Also, the term rubric is used for a text-based analytic rubric.

One of the main characteristics of complex skills is that they are hard to learn, requiring an estimated five hundred hours to acquire [4]. Complex skills are skills that are comprised of a set of constituent skills which require conscious processing [5]. A single skill, such as typing, differs in complexity from a complex skill such as giving a presentation. Giving a presentation is comprised out of several constituent skills, such as using presentation software, communication with the audience and the use of information. A rubric does not

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provide the modeling example needed to contextualize the complex skill and foster a rich mental model [6].

We expect a video modeling example to provide contextualized illustration, supportive- and procedural information to the text-based qualities of a rubric. Bearing practical implementation within Dutch education in mind, using video can provide clear and consistent modeling examples across classrooms.

The highlighted area of Fig. 1 illustrates the core of the general problem definition found in paragraph 8.1 and its position amongst the upcoming theoretical paragraphs.

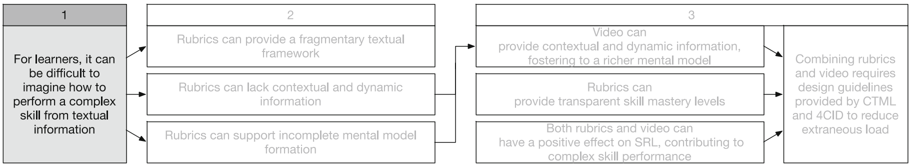

Fig. 1. The core summary of par. 1

2 Specific Problem Definition

Having stated the general problem definition of this paper, a rubric has three specific deficiencies when used for the (formative) assessment of complex skills. In exploring the deficiencies of a rubric, the requirements for video modeling examples present themselves.

Firstly, a rubric provides a fragmentary text-based framework to assess the learner's proficiency of complex skills. Complex skills are comprised of several constituent skills, generally identified by experts through the process of task analysis. However, even though experts are qualified to analyze the constituent skills that form a complex skill, variances may occur in the identification and subsequent hierarchy of constituent skills. Causes for variances can be found in the varying level of expertise and the effect of expert tacit knowledge, causing expert knowledge to be difficult to transfer to a text-based rubric. The varied fragments of a complex skill identified by expert may result in a fragmentary rubric of a complex skill [4]. The fragmentary nature of a rubric may result in an incomplete and moderately reliable assessment of complex skills [7]. An assessment tool with both the ability to assess progress on constituent skill level and assess the progress of the coordination, combination and integration of constituent skills is needed to improve a text-based rubric [5, 6]. We expect videos can 'fill in the gaps' and prevent the fragmentation of constituent skills in a text-based rubric as video provides the learner with the opportunity to personally encode dynamic and contextual information from the video modeling example of the complex skill. Dynamic information refers to information extracted from dynamic stimuli such as video, whereas contextual information refers to information that is connected with real world attributes in order to represent the complex skill within a natural context [8, 9].

Secondly, a rubric is likely to provide an incomplete mental model of a complex skill for low-level learners who perform a Systematic Approach to Problem Solving (SAP) analysison a rubric to achieve a passing grade. In the Four Component Instructional Design

(4C/ID) methodology, performance objectives are formulated to work on constituent skills. The four elements of a performance objective are described on a textual level to form the levels of an analytic rubric. These elements are the (1) tools (2) conditions (3) standards and (4) action the learner should perform to meet the performance objective [4]. Low-level learners use the information found in the performance objectives to strategically reach a passing grade [10, 11]. The learner tackles the problem of reaching a passing grade by analyzing the levels of a rubric for phases and sub-goals, effectively performing a Systematic Approach to Problem Solving (SAP) analysis on the text-based rubric. However, because a learners' mental model is not solely built on the SAP found in a text-based rubric, a rubric should be accompanied with relevant modeling examples. A rich mental model is built on the rich modeling example found in an experts' execution of a complex skill. From the execution of the experts' action, a consciously controlled mental processes can be interpreted by the learner. These expert actions can be visualized in a video modeling example. We expect that the implementation of video modeling combined with a rubric conveys the necessary information to form a rich mental model because the learner may encode the rich mental model found in the actions of the expert performing the task.

Thirdly, the text-based form of a rubric inherently lacks contextual and dynamic information. As complex skills are comprised out of several constituent skills, the priority, sequence and physical performance of the complex skill need to be observed by the learner to supplement the textual assessment criteria with context and dynamic information [9].

In conclusion, we have analyzed several problems with the current implementation of a text-based rubric for the learning process and formative assessment of complex skills. Having specified these problems, we expect the synthesis of video modeling examples and a rubric in the form of a Video Enhanced Rubric (VER) may address these problems, and we move on to the theoretical background of this paper (Fig. 2).

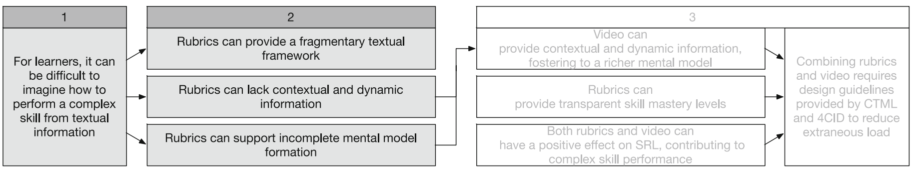

Fig. 2. The core summary of par. 2

3 Theoretical Background of the VER

Having proposed the VER for the (formative) assessment of complex skills, we explore the theoretical arguments for its effectiveness in this paragraph. We start with a brief background on both the text-based rubric and video. Hereafter we analyze overlapping qualities of rubric and video modeling example and finally discuss theory concerning the synthesis of these media into a VER. The theory concerning mental model development, feedback quality, and complex skill mastery is also briefly discussed, as these are the factors we wish to foster by implementing the VER.

As we are using a rubric as a foundation for the VER, we first need to have insight in the qualities of a rubric to understand how they foster the development of complex skills. The transparent grading criteria found in a rubric may be its most important quality, fostering assessment quality and effectiveness, positively influencing the learners' performance [12–17]. From a learner's standpoint, the transparency of a rubric may aid the feedback process by allowing the learner to review the received feedback with the help of the rubric, and provide (self- and peer) feedback based on the rubric. The transparency of a rubric may also allow low-achieving learners to strategically reach a passing grade by providing valuable insight into the minimum requirements per constituent skill [10, 11]. Furthermore, the transparent assessment criteria found in a rubric may reduce anxiety in learners by clarifying teacher expectations if a minimum intervention time of two weeks is factored into the research design as a boundary condition [18–20]. For the assessment of complex skills, a rubric fosters a beneficial effect on self and peer assessment by increasing the validity and reliability of self and peer assessment [1, 7, 21].

One of the research questions of this paper concerns the effect of the VER on the mental model development of a complex skill. A key method used to assess mental model development and also used in this paper, is the creation of a contextual map by the learner. By fostering the representation of knowledge through clear textual descriptions, a rubric fosters the quality of the learners' conceptual maps [1].

Concluding, we expect the transparent skill mastery levels provided by a rubric to foster feedback quality and mental model development of complex skills.

Having summarized the qualities of a rubric and its contribution to the development of complex skills; we proceed to explore the theoretical benefits of the video modeling examples we wish to add to the rubric. We expect better performance of learners on several dimensions making use of the VER, ranging from a richer mental model as a result of the dynamic superiority effect, to increased mastery on specific complex skills.

The dynamic superiority effect proposes advantages of moving images over static visual images [9]. This theory states that moving pictures increase learners' performance because they are remembered better, contain more information, provide more cues to aid retrieval from long-term memory, attract more attention from the learner and increase learner engagement [9]. The dynamic superiority effect also states that the encoding of moving images in a learners' mind involves extraction of semantic and dynamic information, thereby supplementing the rubric's lack of contextual and dynamic information. In the retrieval of the expert modeling example from long-term memory, the modeling example is decoded by the learner. This provides a rich mental model of the complex skill, as the learner visualizes the expert's actions [6, 9]. A richer mental model resulting from the decoding of moving images can relate to higher performance of the learners' complex skills, which is one of the research questions in this paper [22].

Specifically of interest for the development of the complex skill of collaboration, Kim and MacDonough [23] report increased collaborative learning interaction through the implementation of video. The complex skill of presentation has been studied by De Grez et al. [24], finding learning through video to be more effective than extensive practice in the performance of presentations skills. The complex skill of information literacy has been studied by Frerejean et al. [25], finding the effective presentation of supportive information in the form of a video modeling example to cause a strong learning effect.

Concluding, video provides contextual and dynamic information, potentially leading to a richer mental model which can result in improved complex skill performance. However, in order to benefit from the qualities of video, it is important to specify design considerations that guide the synthesis of video modeling examples and a text-based analytic rubric.

In addition to the explored individual qualities of the text-based rubric and video, these media share qualities beneficial to the development of complex skills. Both the text-based rubric and video modeling examples have been shown to foster self-assessment, self-regulatory skills, and self-efficacy [1, 13, 16, 18, 26–31]. Self-regulated learning and self-efficacy may act as a motivational predictor of performance on complex tasks and its constituent processes, such as search, information processing and memory processes that affect learning [29, 32, 33]. Regulated learning is of particular importance for the performance of the complex skill information literacy as the learner constantly monitors and steers the information problem-solving process [34]. Self-regulated learning is also stressed by De Grez [33] as an important factor in the development of the complex skill of presenting. De Grez [33] found significantly increased learning gains as a result of implementing 'self-generated focused learning goals'. In addition to self-regulation, the self-efficacy fostered by both rubric and video is critical in the development of presentation skills and can result in significant learning gains [35].

Concluding, we expect that both rubric and video and have a positive effect on self-regulated learning, which contributes to complex skills mastery (Fig. 3).

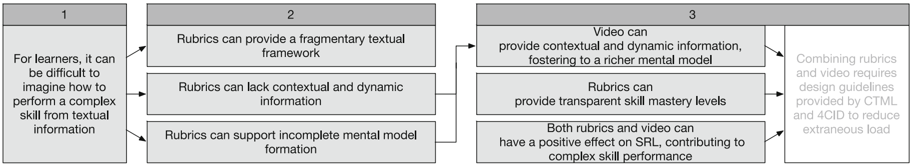

Fig. 3. The core summary of par. 1, 2 and 3

We now examine theory to facilitate the synthesis of video modeling examples and text-based rubric into a VER. The cognitive theory of multimedia learning (CTML) states that learners perform significantly better on problem-solving transfer tests through the combined use of video and text, as opposed to text alone [36]. Within this theory, several principles for the effective implementation of multimedia are described. The CTML principles aim to achieve three goals, namely to (1) reduce extraneous cognitive processing, (2) manage essential cognitive processing and (3) foster generative cognitive processing. First, reducing extraneous load is achieved by lightening the load of the instruction. This can be done by excluding extraneous information, signaling, highlighting and avoiding redundancy. Second, the goal of managing essential cognitive processing is to limit the intrinsic load of the multimedia instruction on the learners' cognitive capacity, preventing essential cognitive overload. Relying mainly on Paivio's [37] dual channel theory, this principle states that the visual channel is overloaded by simultaneously observing a video and reading on screen text. This can be remedied by offloading the visual processing of text to auditory processing by implementing narration. Third, to foster generative cognitive processing, the principles based on social cues are introduced. The personalization, voice and embodiment principles foster a social response, increasing active cognitive processing. According to dual channel theory, active cognitive processing is essential in transferring information from the sensory memory into working memory. This transfer fosters the quality of the learning outcome [38]. Social queuing suggests that active cognitive processing is fostered by the use of natural human voices, gestures and behavior in multimedia as opposed to artificial elements [36]. Another principle contributing to generative processing is embodied cognition [39]. Embodied cognition suggests that the physical engagement of performing a complex skill may foster learning by adding tactile, sensory information to the auditory and visual information provided in a multimedia instruction. Moreno's [40] Cognitive-Affective Theory of Learning with Media (CATLM) takes into account the auditory and visual senses described in CTML, while adding the tactile element of embodied cognition and the olfactory (smell) and gustatory (taste) senses. The CATLM proposes that educationally effective multimedia is not only a result of a cognitive perspective of CTML but also requires the self-regulated learning fostered by both rubric and video, motivation, affect and emotion to engage the learner into actively selecting and processing multimedia.

The stability of the multimedia effect has been recently studied, finding even a relatively simple multimedia implementation may be substantially and persistently more beneficial for retaining knowledge as compared to text alone [41]. However, the inherent complexity of a complex skill is challenging for the limited amount of working memory available to the learner. If the principles are implemented incorrectly, cognitive load is increased, and mental model creation is limited, impacting performance [22]. To ensure effective implementation of video and text, Mayer's [36] CTML relies upon dual channel theory, cognitive load theory and the integrated theory of text and picture recognition [36]. In addition to the principles of CTML, several studies have been done on partial aspects of instructional multimedia design. Eitel and Scheiter's [42] review consisting of 42 studies regarding text and picture sequencing states that it is helpful for comprehension if the medium that contains the least complexity is presented first. Presenting the least complex medium (either text or picture) first may facilitate processing of the complex information presented in the second medium. These findings are in line with both CTML and the 4CID model as the CTML's pre-training principle states that simple information can be used to prime the learner for complex learning [36]. The 4CID model ranges task classes and supportive information from simple to complex to accommodate the sequencing principle [43].

Concluding, theory presenting guidelines for synthesizing video and rubric into a design for the VER is rooted in CTML and 4CID. We expect these theories to allow us to manage the cognitive load of combining a rubric with video modeling examples and the inherent complexity of complex skills. CATLM can then be used to foster the learners' active regulation of the VER (Fig. 4).

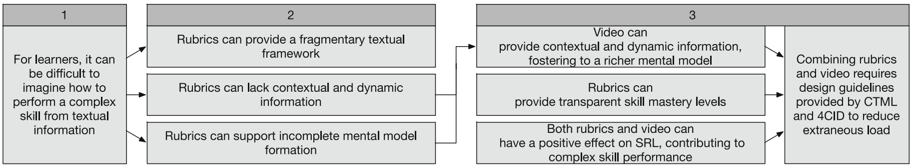

Fig. 4. The completed core summary

4 Conclusion

Analytic text-based rubrics mainly contribute to the development of complex skill on a cognitive level, providing rich feedback, anxiety reducing transparency and performance enhancing insight into the performance levels of a complex skill. However, despite these advantages, three problems regarding formative assessment of complex skills using rubrics where defined. The first problem indicates the aspect level of rubric assessment and states that a complex skill is more than the sum of its identified aspects. We expect that the implementation of video combined with text-based rubricswill help to unify the individual aspects of rubrics into a complex skill. We expect videoto address the first and third problem by ‘filling the gaps’ between the individual aspects of the complex skill as video provides the learner with the opportunity to personally encode semantic and dynamic information from the modeling example of the complex skill, supplementing the information provided by the rubric and providing personalization. The second problem indicates that the information that arubric provides when used as a systematic approach to problem solving by a learner is insufficient to form anaccurate mental model of a complex skill. For a video to convey the appropriate information to form a mental model, it is of importance that the modeling example conveys the mastery of the complex task in such a manner that the learner can encode the rich mental model found in the actions of the professional performing the task.

Concluding, we expect video to provide a rich enhancement to text-based rubrics for the specific use of (formatively) assessing complex skills. However, to ensure effective multimedia implementation it is of importance to adhere to CTML principles. In summary, we have taken a first step towards asynthesis of video and analytic text-based rubrics. We will focus further study on the development of design guidelines for effective implementation of video and analytic text-based rubrics for the (formative) assessment of complex skills in the Viewbrics project. Information on the Viewbrics project can be found on www.viewbrics.nl.

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