Video-modelling in Physical Education

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Video-modelling in Physical Education is a collaboration between the Research Centre for Exercise, School and Sport at the Windesheim University of Applied Sciences in Zwolle, the Department of Human Movement Sciences at the *Vrije* Universiteit in Amsterdam, the Dutch Expertise Centre for Curriculum Development (SLO) in Enschede, the School for Physical Education (CALO) at the Windesheim University of Applied Sciences in Zwolle, the OSG Northgo in Noordwijk, the Van der Cappelen Scholengemeenschap in Zwolle, the Greijdanus Scholen Gemeenschap in Zwolle and the Carolus Clusius College in Zwolle .

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Contents

1. Video-modelling in Physical Education

The use of digital means in physical education (PE) is not a new phenomenon. An increasing number of PE-teachers have adopted computers, tablets, and/or smartphones in their lesson, or considers doing so. This development has brought – among other applications– the use of video-modelling to the attention of PE-teachers. Yet, the revenues of video-modelling are still largely unknown. To what degree does adopting video-modelling really promote motor skill learning and/or how students experience physical activities in terms of motivation and self-efficacy? And also: how should video-modelling be implemented; what models should be presented and in which manner; are additional (attention directing) instructional features needed, or can we do without; and when should video-models be made available, when students start practicing a new activity or is it more beneficial to put video-modelling to use further in the motor learning process, in later lessons? Perhaps surprisingly, but the scientific literature does not provide many evidence-based answers to these questions, and the studies that did start to investigate these issues typically did not address them in the context of physical education (i.e., 'in the classroom'). Hence, the current project *Video-modelling in physical education* aimed to make a start in providing more evidence-based guidelines for the implementation of digital video-modelling in PE. It does so primarily by empirically investigating its benefits in PE lessons, but also by drawing on the extant empirical literature.

Video-modelling involves using (digital) videos both as method for instruction, in which students watch other persons as a model, and as a method for feedback, in which students watch their own performance after some delay (Hodges & Ste-Marie, 2013). Teachers (and researchers) intuitively attribute a better understanding of the to-be-learned activity, increased performance, and improved motivation and self-efficacy to students learn with video-modelling. Despite its popularity, however, teachers (and researchers) also question whether the revenues or gains they anticipate from working with video-modelling in PE do actually arise, or alternatively, how to effectively integrate video-modelling in their lessons to actually accomplish these gains. A PE-teacher who, for example, aims for students to monitor or evaluate their progression in a gymnastics exercise, may wonder whether the students are actually able to pinpoint the relevant information in the video-displays to enhance learning in subsequent practice; or when in a series of lessons video-modelling is most effective, or perhaps only a hindrance for progress.

The available scientific literature offers many insights and ideas for effective application of video-modelling in motor skill learning in general. However, most of this research is conducted in university laboratories and did involve university students as their participants. This raises the issue to what degree these findings are representative for motor skill learning in PE. Hence, this report describes two studies that address two general questions with respect to the use of video-modelling as a method for instruction and feedback. First, we investigated the requirements for a video-model. Who should or should not be the model, and what instructional features should or should not be added to the model. To this end, in Phase 1 (see Chapter 2 below) the effectiveness of different models and different instructional, attention directing features are compared. Second, we examined when during a series of lessons in which students practice to learn a new activity, the use of video-modelling is best integrated. In other words, should video-modelling be used at the start of learning (i.e., in the first lesson when the new activity is introduced), or is it more effective to include it later in learning (i.e., in the second or third lesson). And also, if video-modelling is not directly beneficial, does it hamper learning dependent on when it is used? This question was addressed in Phase 2 (Chapter 3). Finally, based on the findings in Phase 1 and 2, courses for different activities were developed and – among others– published by the Dutch Expertise Centre for Curriculum Development to be accessible for PE-teachers (Chapter 4).

2. Phase 1: The video model

2.1. Introduction

The literature strongly indicates that merely providing video-models to learners is unlikely to be beneficial. Novice learners are typically insufficiently equipped to know what information they must extract to support learning. For example, without further guidance, novice learners do not know what events in the video-display are relevant and must be attended to. This is also likely to be true for PE-students. PE-teachers thus must carefully plan the use of video-modelling in their lessons. In fact, the literature has identified a very large number of factors that influences the efficiency of video-modelling for motor skill learning, self-efficacy and motivation. Figure 1, which is taken from a recent review by Ste-Marie et al. (2012: see also Hodges & Ste-Marie, 2013), provides a succinct summary of all these interacting factors.

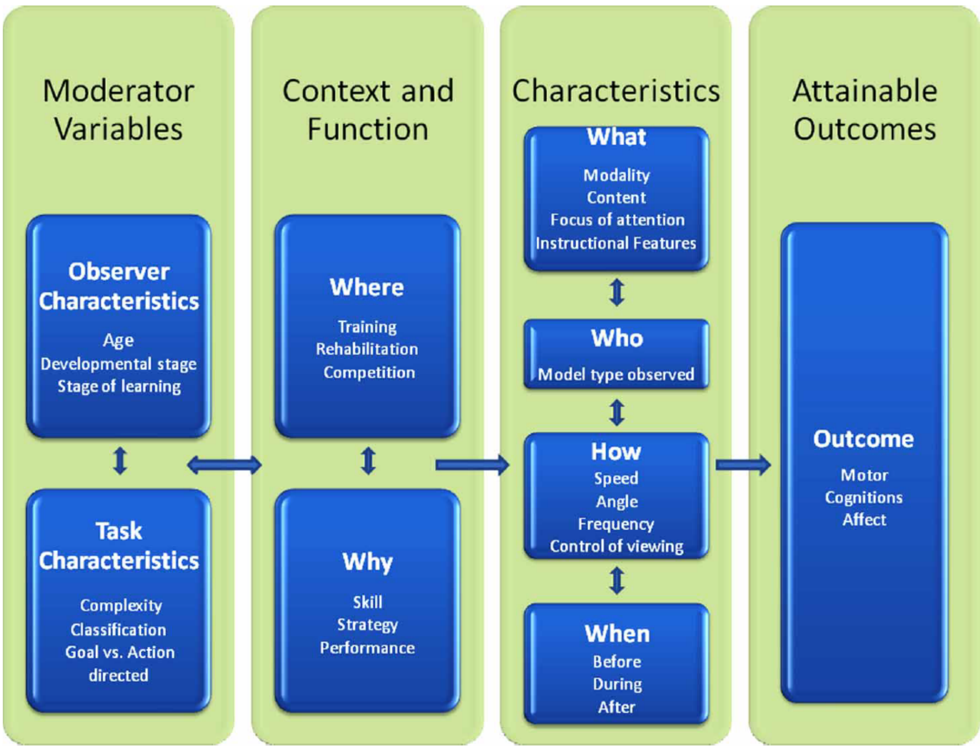

***Figure 1**: An applied model for the use of video-modelling, illustrating the many factors that need to be considered for implementation (taken from: Ste-Marie et al., 2012)*

Phase 1 (Section 2.3) of the current project did focus on the instructional features that improve focus of attention to relevant information ('what'-box, Figure 1) and the model characteristics that are paramount for conveying this information ('who'-box, see Section 2.2). Next, Phase 2 (Chapter 3) studied the timing of the use of video-modelling within a series of lessons ('when'-box, Figure 1).

2.2 Study 1: Model characteristics[1]

2.2.1. Background and question

Who should be the model? In theory, a PE-teacher can take into account many characteristics when choosing a model, such as age, gender, and skill to name a few. One relevant dimension that has been distinguished concerns coping and mastery models. Coping models are models that demonstrate the activity at a similar skill level as the learner and additionally verbalize perception of their (lack of) ability and confidence regarding the performance of the activity. Mastery models, by contrast, are models that are very capable of performing the activity properly (or dexterously), demonstrate it with ease and express their positive thoughts about their ability and confidence. The general, but largely unsubstantiated opinion is that mastery models are more effective in promoting motor skill learning, while coping models are more effective in promoting the learners motivation and self-efficacy (e.g., Ste-Marie et al., 2012; Van der Zee, 2016, Weiss et al., 1998). In fact, some have argued that showing PE-students a model that develops from coping to mastery may be preferred, because it would enhance both motor learning and students' perceptions (Hodges & Ste-Marie, 2013; Van Berkel & van Mossel, 2014). Hence, we conducted an experimental study to investigate whether a coping, mastery or developing model is most beneficial in learning a round-off vault during a series of three lessons. Learning was evaluated both in terms of motor performance and self-efficacy.

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[1] This question was not part of the original project plan, but was added to it based on questions from PE-teachers early in the project. We thank Aliene van der Zee for taking up this issue as a research project for her MSc-thesis. Because this is an addition to the project, the report is less elaborated than with respect to the other two experimental studies. The interested reader is referred to the technical report of Van der Zee (2016) or to Van der Zee and Van der Kamp (2016) for a more accessible report (in Dutch).

2.2.2. Method and results

Three groups of second grade HAVO- and VWO-students (i.e. secondary school), ranging between 12 and 14 years participated in the study (n= 72). The students practiced a round-off on a vault with mini trampoline for 30 minutes in two PE-lessons. Immediately after each attempt, the student had the opportunity to watch a video-model on a tablet practice, but it was mandatory to watch the model before the first trial and after the second attempt (in each lesson). Three groups either watched a coping, mastery or the developing model. In addition, a PE-teacher was allowed to provide verbal feedback, but only according to performance criteria provided by the Dutch Expertise Centre for Curriculum Development. A week before (pre-test), immediately after (post-test) and 4 weeks after practice (retention test) the students were tested on their performance and completed questionnaires regarding their perception of the activity.

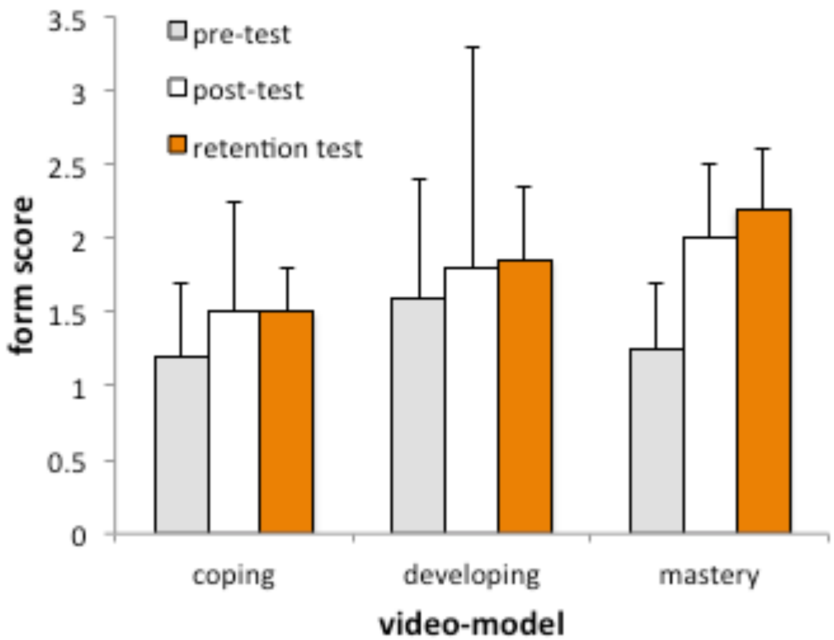


Figure 2*: Form scores as function of the type of model and test. Vertical bars indicate standard errors. The group that practiced with the mastery model shows the largest performance improvements.*

Figure 2 shows the main findings of the study. It shows that all groups improved performance from pre- to post-test, and this improvement was maintained during retention. Importantly, however, Mann-Whitney tests revealed that while there were no differences between the groups at the pre-test, differences had become significant in the post-test, H (2) = 9.08, p = .01, and remained different in the retention test, H (2) = 9.08, $p < .05$. Post hoc indicated that performance of the group that used the mastery model was superior to performance of the groups that had used the coping and developing model. There were no meaningful differences between tests and groups with respect to self-efficacy and task motivation.

2.2.3. Discussion

The results show that the use of a mastery video-model that shows successful performance, results in enhanced motor learning relative to a coping model that demonstrates unsuccessful performance. However, the different video-models did not differentially influence how students perceived or experienced the performance of the activity.

Although a mastery model led to more successful learning, in the main study of this project (see Chapter 3) we decided not to use mastery models that performed successfully according to criteria for the highest skill level. Instead, we decided to use video-models that were successful but only according to the criteria at the skill level they were performing (We also removed the models' verbal comments on their performances). Perhaps we can label these skill-level specific mastery models rather than coping models, which do fail or make errors. We decided for this, because we presumed that these would allow us to best adapt the skill level of the model to the skill level of the student, which is shown to be important (e.g. Hodges & Ste-Marie, 2013). Also, we anticipated that by using skill-level specific mastery models this would possibly increase self-efficacy as well.

2.3 Attentional cueing

2.3.1 Study 2: background and question

What instructional features help direct attention to relevant information in dynamic video-displays? Novice learners need further guidance to search for relevant information in video-models. The most straightforward manner for a PE-teacher to offer such guidance is by verbal explication. However, for a PE-teacher it is not always feasible to do this for all individual students, and sometimes it is downright impossible (Van der Kamp et al., 2015). Obviously, digital video-modelling provides the opportunity to edit the verbal guidance instructions into the video clip. Yet, even with verbal guidance novice learners experience difficulty in selecting relevant over salient information from video-models, especially when –as would be typical for physical activities– dynamic models are used (Jarodzka et al. 2013). Hence, researchers have investigated the use of visual cueing in video-modelling for learning new skills. They did this by editing the video-displays, for instance, by superimposing markers such as arrows, circles, lines etc. Janelle et al. (2003), for example, demonstrated that cueing by visual marks and verbal explications increases learning of a soccer pass in (young) adults relative to cueing by verbal explication alone. It is not particularly clear if this is also true for children.

Alternatively, Jarodzka et al. (2010, 2013) used a method for cueing they dubbed *eye movement modelling examples (EMME).* Rather than using visual marks, they recorded gaze patterns of a teacher while he or she provides verbal explications about the video-model. They showed that the spatio-temporal characteristics of the teacher's gaze patterns are synchronized with the verbal explications. They then edited the video-model by superimposing the gaze pattern (in the form of a dot or spotlight) onto the display. Jarodzka et al. show that these methods are helpful for adults to attend to and extract relevant information. This research entailed academic tasks, not motor learning.

Hence, we examined what type of instructional features, verbal explications only, verbal explications with visual marking or verbal explications with EMME, best help secondary school children to focus attention to the relevant information to identify whether or not the motor performance of the video-model contains errors.

2.3.2. Method and results

Forty-two (ages 12-14) second grade HAVO- and VWO-students completed the experiment. The participants watched video-models of other students performing the forward roll dismount from supported trapeze swing and rated the performance quality of separate aspects of this activity. The video-displays directed attention to relevant events in three different ways: verbal explications only, verbal explications with visual marking or verbal explications with EMME. We examined which of three types of attentional cueing resulted in the most accurate perception relative to an expert judge.

The video-models were prepared as follows. First, recordings were made of students (from a different school) performing the forward roll dismount from supported trapeze swing in a non-distracting environment (i.e. gym). The models had different levels of skill, but performed the activity successful according to their skill level. Second, an experienced PE-teacher watched the recordings and provided verbal explications of performance-related aspects of the activity (as he would explain the activity in class). The verbal explications drew attention to the technical and timing aspects of the activity, and specifically addressed reaching the supported swing, the swinging, and the timing of the onset of the forward roll. Concurrently, the experienced teacher's gaze patterns were recorded using the Tobii x50 eye tracker. Next, Adobe Premiere Elements 11 was used to produce three types of video-models. First, the verbal explications were added. This produced the verbal explication only model. In addition, for the visual marking model, a circle around the arms and shoulders while the model was reaching the supported swing position and a line projected on the floor representing the position of the suspension point were superimposed on the images. Also, the word "turn" appeared as soon as the model approached this line during the second swing, and meant to draw attention to the correct timing of the forward roll. This produced the verbal explication plus visual marking model. Finally, using the experts gaze recordings, a spotlight was added that represented the expert's gaze pattern. This produced the verbal explication plus EMME model. Stills of the visual marking and EMME video-models are shown in Figure 3.

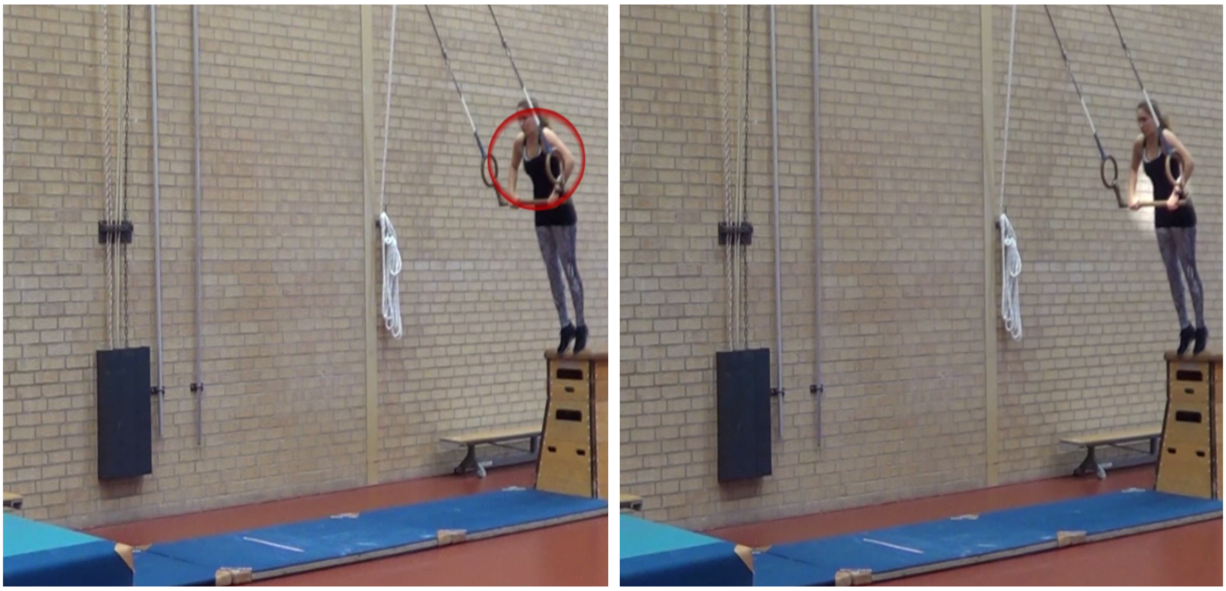


Figure 3*: A still from the video-model with visual marking (left) and EMME (right).*

The participants were presented with a series of video clips that showed models with varying skill levels of performing the trapeze dismount. The criteria used to define skill levels for two aspects (i.e. supported swing, forward roll dismount) of the trapeze dismount can be found in Table 1. The videos were shown in a PowerPoint presentation on a laptop computer (Fujitsu Siemens Lifebook) equipped with a Logitech USB-headset.

Table 1: Criteria for the three skill levels of performing the trapeze dismount

Performance level	***Supported swing***	***Forward roll dismount***
1 (low)	Reaches support during the first front swing	Rolls slowly and after the suspension point
2 (average)	Stable support quickly after push-off	Rolls above or just before the suspension point
3 (high)	Adds speed during push-off and quickly reaches stable support.	Actively starts roll just past the suspension point

The participants were divided over three groups that watched a different type of model: verbal explication only, verbal explication plus visual marking, and verbal explication plus EMME. The participants were tested in a classroom with a maximum of eight children participating at the same time. Participants first received a general verbal instruction about the task. Specifically, they were told to rate the performance level of either the supported swing or the forward roll dismount according to the criteria provided in Table 1. Participants were first shown the video-model twice (i.e., with attentional cueing depending on the group), and then rated 16 videos without attentional cueing showing students of similar age performing the forward roll dismount from supported swing. After every third or fourth clip, the video-model (with attentional cueing) was shown again. The participants rated every video for one aspect of the activity only, that is, either reaching support or the onset of the roll (counterbalanced between participants).

The ratings of the participants were compared to the ratings of the experienced PE-teacher. The total percentage of correct ratings (i.e., agreements with the expert judgement) served as the dependent measure. Figure 4 presents the results for the three groups. As can be seen, participants correctly identified the video-model's performance level in about half of the clips. One sample t-tests showed that this significantly exceeded chance levels (i.e., 33%). However, a further one-way ANOVA revealed no significant differences as function of type of video-model on the percentage of correct ratings, $F(2,39) = 0.288$, $p = 0.751$.

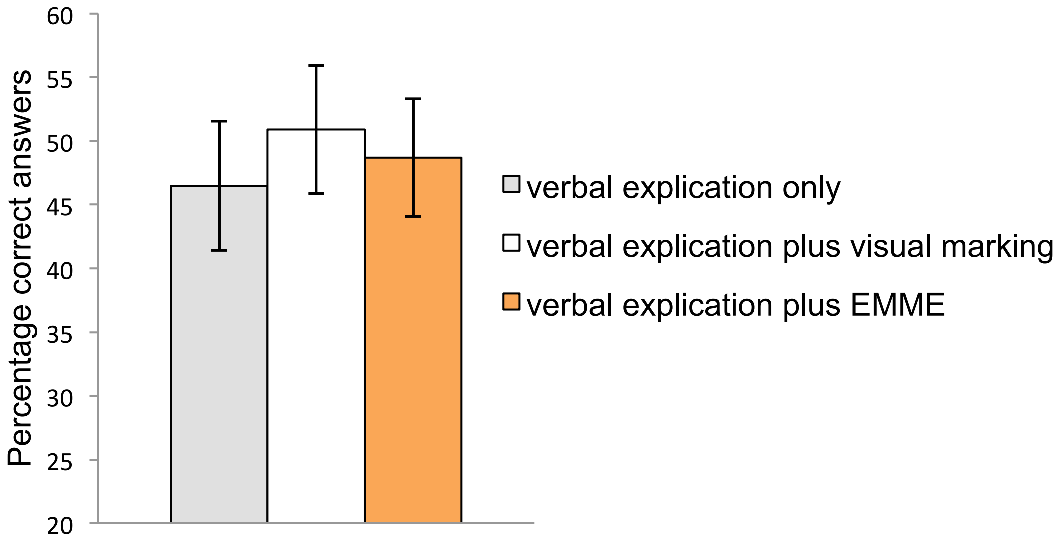


Figure 4: *Total percentage of correct ratings as a function of type of model. Vertical bars indicate standard errors. There were no significant differences between the type of attentional cueing.*

2.3.3. Discussion

Study 2 showed that secondary school students can identify the performance level of peers above chance. Supposedly, they are capable of extracting and evaluating information about the quality of different aspects of an activity, based upon a short general explication and the observation of video-models. Yet, it is also clear that it is not an easy task for them: in half of the trials they were incorrect. Unfortunately, we can only speculate about the reasons for this –perhaps mediocre– perceptual accuracy. In fact, we even do not know, whether this level of accuracy is typical, lower or higher with respect to their normal ability to interpret verbal explications and/or live demonstrations during regular physical educations lessons.

Importantly, we were not able to discern differences between the different types of video-modelling. Visual marking and EMME had no clear benefits but certainly also no disadvantages over verbal cueing alone. Hence, given the reported positive effects of EMME elsewhere (Jarodzka et al., 2010, 2013: De Koning & Jarodzka, 2016), we choose to use eye movement modelling examples as an instructional feature for focussing attention in addition to verbal explications in Phase 2 of the current project (Chapter 3).

3. Phase 2: When to use video-modelling

3.1. Introduction

A pressing question among PE-teachers concerns 'when' to integrate video-modelling in their lessons. They often feel that video-modelling is only helpful after students have achieved some minimum level of performance; students should at least succeed in performing the task. However, is it really true that video-modelling at the start of learning (i.e., in the very lesson the activity is introduced for the first time) is not beneficial or perhaps even harmful? These questions are also grounded in uncertainty among PE-teachers about the degree to which using video-modelling goes at the expense of actual physical practice. From a scientific point of view there are two issues here: first, how should instruction and feedback be scheduled during a motor learning process (see e.g., Salmoni et al., 1984 for an early overview), and when during the learning process can video-modelling support (or perhaps harm) the provision of instruction and feedback.

Traditionally, it is presumed that especially early in learning, in the so-called verbal-cognitive stage (Fitts & Posner, 1967), augmented instruction and feedback is necessary for motor learning to proceed. Instruction and feedback helps a novice learner to consciously understand not only the goal of the activity, but also how to perform the activity. It helps the learner to build a reference of correctness through which they can identify errors and develop strategies to avoid them (Schmidt & Lee, 2011). Consequently, the provision of instruction and feedback are strongly related to learning. However, there is one important caveat: the frequency of instruction and feedback must be reduced with learning (Salmoni et al., 1984). Salmoni et al. (1984; see also Aiken et al., 2012; Chiviacowsky & Wulf, 2002; 2007) showed that reducing the relative frequency of feedback enhances learning in adults. That is, if frequency remains high than a learner becomes dependent on instruction and feedback, and motor performance is very likely to drop dramatically if instruction and feedback are withdrawn. The learner has not learned to plan and guide the activity on his or her own. There are some indications that children require higher frequency of instruction and feedback, but it appears that also for children a diminishing schedule is most effective (Chiviacowsky et al., 2008; Ste-Marie et al., 2013).

With respect to the provision of instruction and feedback (including video-modelling), these findings are only partly helpful. In particular, it is unclear how a series of consecutive PE-lessons (in the Netherlands typically three) compares to the time scale of learning that forms the basis for scientific theories and observation. In addition, many PE teachers seem to prefer verbal instructions and positive reinforcement at the onset of learning and add video-modelling later, thus perhaps using an *increasing* feedback frequency rather than a decreasing schedule.

In sum, we decided to take an empirical perspective without formulating strong hypotheses. That is, we aimed to compare the effect of integrating video-modelling in different lessons in a series of three. To this end, we compared motor learning after three lessons in three groups of students that either used video-modelling in the first, second or third lesson. We used skill-specific mastery models (i.e., adapted to the expected skill levels in each lesson, see Section 2.2.) that were supported with verbal explications plus eye movement modelling examples (i.e., EMME, see Section 2.3) as models. Students (in dyads) practiced the forward roll dismount from supported trapeze swing and, in one of the lessons, recorded their practice to watch and compare it to video-models. Hence, the video-modelling lesson entailed both instruction and feedback. The other two lessons were without video-modelling. Except for amount of motor learning, we also examined students' motivation and self-efficacy.

3.2. Method

Participants Sixty-three (ages 12-14) second grade HAVO and VWO-students participated in the experiment. Both the children and their parents gave informed consent prior to participation. Fifty-eight students completed the entire study.

Video-models Six different video-models with verbal explications and EMME were produced. The models were three boys and girls with increasing skill level (i.e., beginner, intermediate, advanced) from the same age group as participants. The EMME was produced as per Study 2 (see Section 2.3.3); yet, the verbal explications were added later to synchronize them with unfolding of the activity, and recorded while the narrator was observing the model with EMME.

Task Students practiced a forward roll dismount from supported swing (Figure 5) in three 30-minutes lessons across three consecutive weeks. The activity was performed from a vaulting box (h = 0.90 m) that was 3.5 m away from a landing mat (300 x 200 x 12 cm). Practice mats were on the floor between the vaulting box and landing mat. Students stood on top of the vaulting box holding the trapeze bar in front of them, just above hip height. Students were to gently reach supported swing by leaning forward, and in the second forward swing, to perform a forward roll dismount and land on their feet. The three practice sessions were pre-planned to accommodate the increasing skill of the students. Roughly, the first lesson introduced the activity and students practiced stable support and a basic forward roll dismount. The second lesson students practiced the timing of the dismount, and the third aimed to increase the speed and height of the forward roll dismount. At this stage, students were allowed to release the trapeze bar during their forward roll dismount.

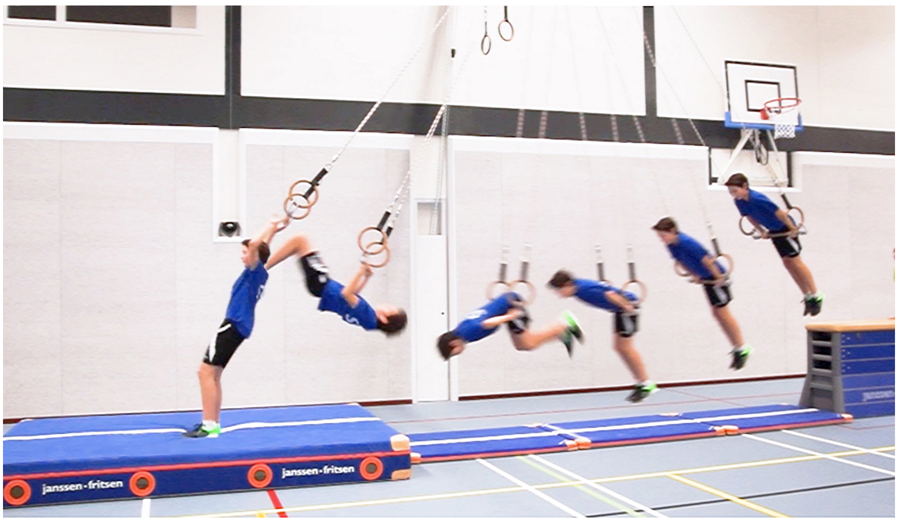


Figure 5: *The forward roll dismount from supported swing.*

Procedure and measures The content of instructions and feedback were the same for each of three groups. One class formed each of three groups. They were distinguished through when video-modeling was integrated in the lesson: in the first lesson (i.e., early intervention, EI), in the second lesson (mid intervention, MI) or in he third lessen (late intervention, LI). At the beginning of the first lesson –for all three groups– the activity was introduced and demonstrated once by the teacher. At the very start, students received verbal instruction on the activity's general structure, and were, for safety purposes, called on to hold the bar at all times.

In the lessons in which the video-modeling was used, students were told that the video-modeling was available to assist them in mastering the activity. To this end, two Apple iPad air tablets were used. One of these tablets showed the video-model with verbal explication and EMME, while the other was used to record the students' performance and to be used for feedback. The video-models were available in iBook, and sorted by gender and skill level. The freely available app O'See Video Delay LITE (O'sports) was used to show the attempt after a 20 second delay. Students were advised that they could consult the model or delayed feedback tablet, at all times they thought it would be helpful. This so-called self-controlled feedback has proven effective for learning complex motor skills in a PE-setting (e.g., Schoffelmeer, 2016[2]; Ste-Marie et al., 2013). The students were frequently reminded of the availability of video-modeling. Although the video modeling can be used teacher-independent, the teacher accompanied several feedback consultations by posing questions about relevant aspects demonstrated by the video-model (e.g., Table 1). In the lessons, without video-modeling, the teacher also provided regular verbal feedback and tried

[2] In fact, the study by Schoffelmeer (2016) was a second additional study added to the original plan of the project, and was conducted as a research project for an MSc-thesis. Briefly, the study compared the learning of Fosbury flop in high jumping in a self-regulated feedback group (i.e., students could chose after each trial whether or not they wanted video-feedback of their own performance) with a traditional instruction in grade 3-4 of VWO schools. It shows superior learning and self-efficacy in the self-regulated feedback group. We are currently preparing a scientific report on this study (Kok, Schoffelmeer & van der Kamp, in preparation).

to actively involve the students in mastering the skill. All lessons were recorded using three Panasonic HC-V770 wide-angle HD camcorders.

At the end of each lesson and three weeks after the third lesson (retention), the performance of the students was tested. The teacher first demonstrated the activity, after which the students were asked to perform the skill twice. Just like during the practice, students only attempted the front roll dismount when they felt comfortable enough to do so. Otherwise they could end support without a roll.

Table 2*: Points granted for three aspects of the activity. The sum of points served as performance measure.*

Points	***Supported swing***	***Forward roll dismount***	***Landing***
3	Reaches support with extended arms during the first forward swing.	Rolls actively, creates speed with the legs.	Has a stable landing without corrections.
2	Does not extend arms, or reaches support after the first forward swing.	Rolls passively, 'falls' over the trapeze.	Has a controlled landing, but needs a correction.
1	Does not reach support.	Does not roll.	Falls backwards, or lands with forward speed.
0		Did not reach support.	Did not roll.

Analysis The performances were recorded and edited for further analysis. Four final-year PE teacher education students ('Calo-students') served as observer and graded the performances according to a modified version of the criteria in Study 2 (see Table 2). Before grading, the observers attended a training session in which the ratings were explained, illustrated and practiced. After this session, inter-rater agreement was moderate to substantial. This was mainly due to one observer giving relatively low scores. Hence, in a second training session grading was discussed once more by illustrating the differences between observers. This resulted in near perfect inter-observer agreement. The points for each aspect of the activity were summed to provide total form score for each performance, of which only the best out of two attempts was selected for further analysis.

Finally, before the first and at the end of each lesson, the students completed short questionnaires. The responses to these questions were made on 7.5 cm visual analogue scales that ranged between "I do totally agree" to "I do not agree at all" (Table 3). Questions 1 and 2 served as measures for motivation, and the remaining final questions served as a measure for self-efficacy (see e.g., Ste-Marie et al, 2013, for similar procedures).

Table 5: Questions used to gauge motivation (1 & 2) and self-efficacy (3, 4 & 5)

Pre-practice	***Post-practice***	***Question***
1	1	I like the trapeze skill
2	2	I think it's important to be able to perform the trapeze skill
	3	I became better at the trapeze skill because of the practice.
	4	I tried hard to become better at the trapeze skill
3	5	I can perform a forward roll dismount.

3.3. Results

Practice Figure 1 shows moderate increases in form score over the course of the three lessons among the three groups. Yet, there is no clear difference between groups: that is, there is no difference in performance as a function of when the video-modelling was used. Accordingly, the analysis of variance with repeated measures on the form scores revealed a significant main effect for lesson, $F(2,120) = 5.128$, $p = 0.007$, $\eta_p^2 = 0.079$. Post hoc indicated that performance in the second and third lesson was enhanced relative to performance in the first lessons. There were no differences between groups.

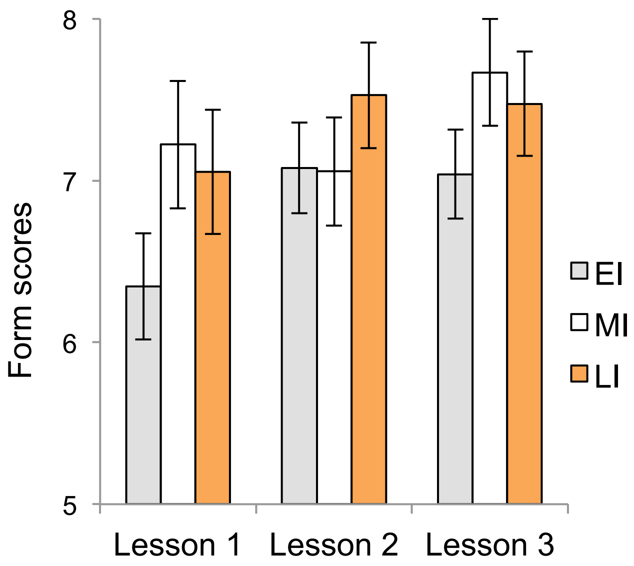
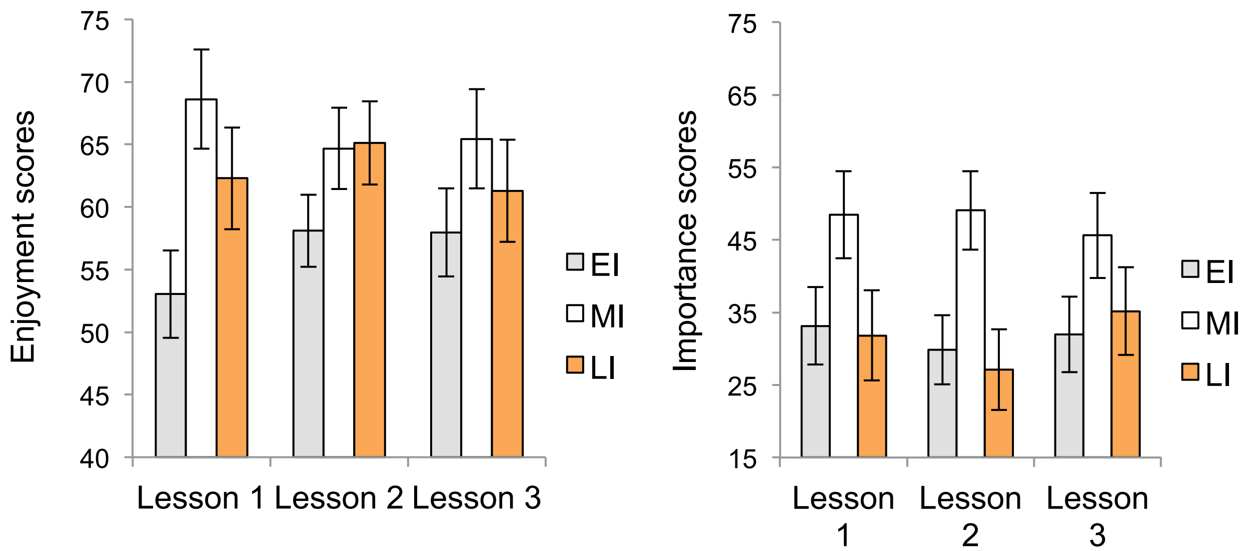


Figure 6: *Form scores during practice session as a function of lesson and group. EI, MI, and LI received the video-modelling in the first, second and third lesson respectively. Error bars indicate the standard errors. All groups improved performance score in an equal amount during practice.*

Figure 7 displays the students' rating during practice for enjoyment, motivation and self-efficacy for each of three practice sessions. Analyses of variance did not show any systematic changes in the self-regulation variables occurred during practice or differences between groups.



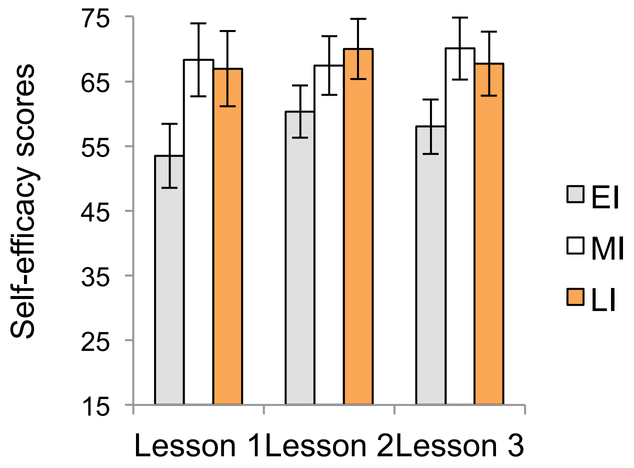


Figure 7 *Ratings for enjoyment (a), importance (b) and self-efficacy (c) during practice session as a function of lesson and group. EI, MI, and LI received the video-modelling in the first, second and third lesson respectively. Error bars indicate the standard errors. No differences between lessons or group were found.*

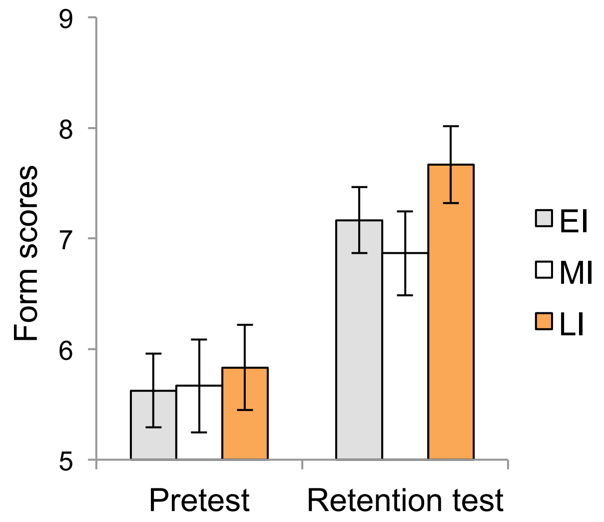


Figure 8*: Form scores during pretest and retention as a function of group. EI, MI, and LI received the video-modeling in the first, second and third lesson respectively. Error bars indicate the standard errors. All groups improved form score in an equal amount.*

Learning Figure 8 shows that all three groups increased performance from pretest to retention test, but in a similar magnitude. Accordingly, an analysis of variance with repeated measures confirmed a significant main effect for test, $F(1,54) = 62.21$, $p < 0.001$, $\eta_p^2 = 0.54$. Yet, neither a main effect for group, nor a significant interaction between group and test were found.

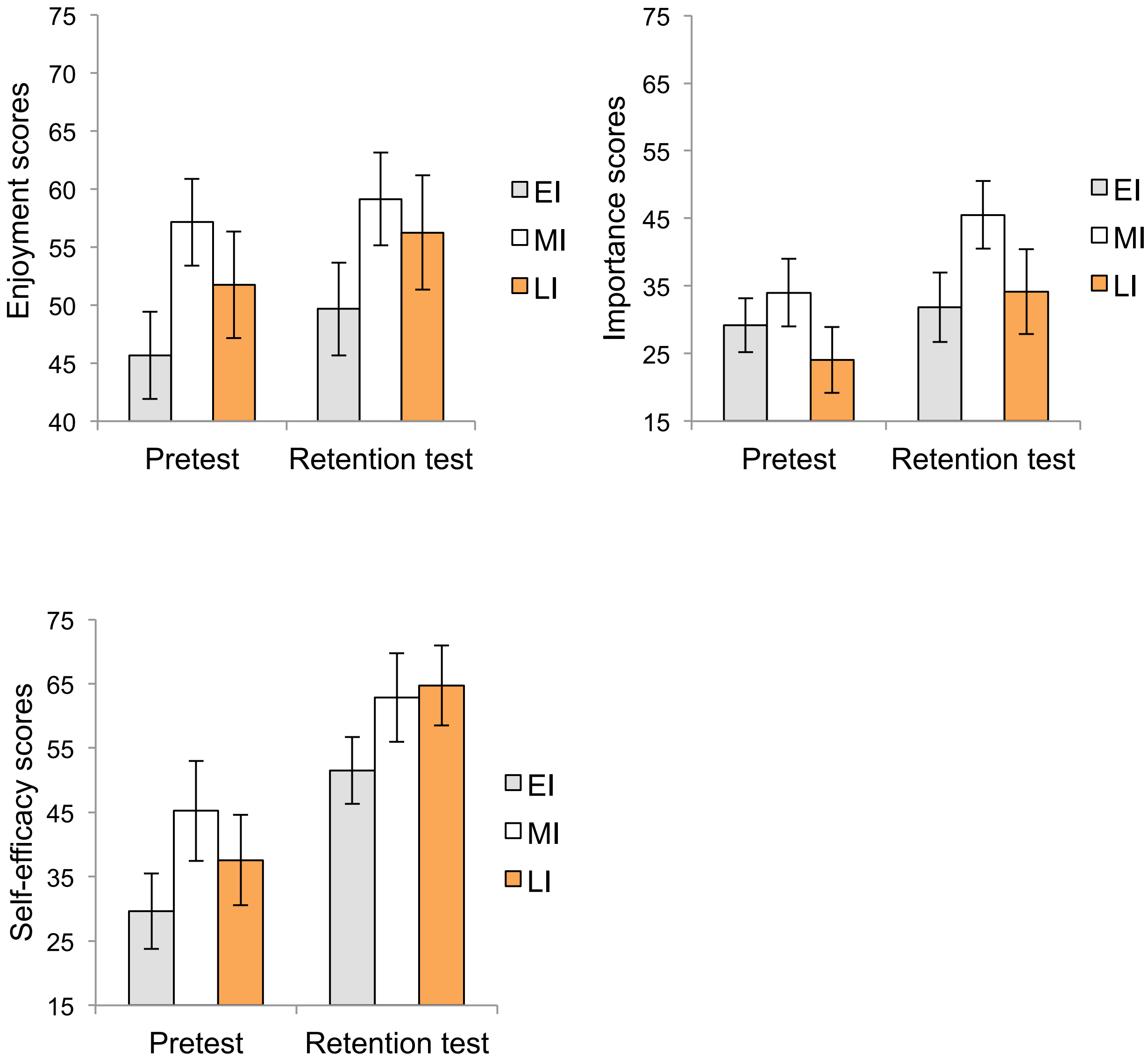


Figure 9 *Ratings for enjoyment (a), importance (b) and self-efficacy (c) during pretest and retention as a function of group. EI, MI, and LI received the video-modelling in the first, second and third lesson respectively. Error bars indicate the standard errors. Importance and self-efficacy were higher in the retention.*

Although Figure 9a perhaps suggests a slight increase from pre- to retention test, analysis of variance did not confirm significant effects for enjoyment ratings. However, the students significantly rated the activity as more important during retention test than during the pretest, $F(1,51) = 12.36$, $p < 0.01$, $\eta_p^2 = 0.20$, but this effect was not different between groups (Figure 9b). Also for self-efficacy a steep increase was found from pre- to retention test, $F(1,49) = 27.46$, $p < 0.001$, $\eta_p^2 = 0.36$ (Figure 9c). However, the analysis of variance did not reveal significant effects for group and group by test.

Predictors of learning Finally, a hierarchical regression analysis was performed to determine whether group (step 1) and the averaged enjoyment, perceived importance and self-efficacy rating during the lessons (step 2) predicted changes in form score between pre- and retention test (i.e., learning). Neither the model that included only group, $F(1,52) = 0.79$, $p = 0.38$, $R^2_{adj} = -0.004$, nor the model with both group and enjoyment, perceived importance and self-efficacy, $F(4,52) = 0.39$, $p = 0.81$, $R^2_{adj} = -0.049$, proved to be significant predictors for change in form scores.

3.4 Discussion

The students clearly improved their skill in performing the forward roll dismount from supported swing and also their motivation and self-efficacy performing the activity. However, and perhaps somewhat unexpectedly, the lesson in which the video-modelling and feedback was introduced did not influence learning of the activity or how students perceived the activity. Consequently, we cannot further delineate when PE-teachers can best introduce video-modelling. That is, we did not find evidence to support some PE teachers' contention that video modelling should only be introduced after the students have the ability to at least succeed (i.e., presumably during the second or third lesson). Put differently, we do show that introducing it early, in the first lesson, does not hamper learning as compared to introducing it later in learning. In fact, because we decided not running a control group (within the time-constraints of the project, this was unfortunately not feasible), we cannot be one hundred per cent confident that the video-modelling did have any beneficial effect at all. However, previous findings, including our own (see Van der Zee & van der Kamp, 2016, Section 2.2, Kok e.a., in preparation, see footnote 2) do not lend much credence to such a null scenario. Yet, it is important to note that it cannot be ruled out either.

In sum, we find no evidence that the timing of the introduction of video-modelling and feedback affects motor learning or perception of enjoyment, motivation and self-efficacy. To some degree this is reassuring, because a PE-teacher can choose its use when it is convenient. This been said, it must be kept in mind that we attuned the video-models to the expected skill level in each lesson. Hence, although we cannot convincingly show this, it may be of importance to use such skill-level specific mastery models.

4. Implementation

4.1. Summary of main findings

PE-teachers increasingly (intend to) use video-modelling in their classes. Yet, adopting new means for providing instruction and feedback also leads to new questions. In this project, we addressed two of these questions. First, when using video-modelling; who should be the model and what instructional features should be used? And second; if integrating video-modelling in PE, when within a typical series of three lessons should it be used?

Phase 1 (Chapter 2) examined the type of model and the instructional features that facilitate students' pickup of relevant information. It was found that successful models (i.e., mastery model) enhance motor learning relative to unsuccessful models, while the two video-models did not differentially influence students' perception or experience of the activity (see also Ste-Marie et al., 2012). In addition, it was found that students were capable of detecting important information from the video-modelling, but also that they did make frequent mistakes. Importantly, above chance judgements were made for each of three instructional features that were assessed: with verbal explication only, with verbal explication and visual marking and with verbal explication and EMME. Visual marking and EMME, however, had no clear benefit over verbal explications alone. Also taking into account previous findings (see for overviews, de Koning & Jarodzka, 2016; Ste-Marie et al., 2012), we created skill level specific mastery models (i.e., models that were successful but only according to the criteria at the skill level they were performing) with verbal explication and EMME to be used in Phase 2.

Phase 2 (Chapter 3) examined when, within a typical series of three lessons, instruction and feedback with video-modelling is most beneficial. The results indicated that – although all three groups improved performance levels and the way they experienced or perceved the activity, making video-modelling available in either the first, the second or third lesson did not yield any significant increases or decreases in motor learning or perception of the activity. In other words, we found no evidence that an early introduction of video-modelling would hamper learning, or for any other difference in the effect of video-modeling as a function of when in a series of lesson it is made available. Although the current study in itself did not provide further evidence for the benefits of video-modelling, the recent literature reports increasing evidence supporting the use of video-modelling (Aiken et al., 2012; Hodges & Ste-Marie, 2013; Kok et al., 2016; Ste-Marie et al, 2013). Consequently, we do advice the use of video-modelling; we cannot provide recommendations when its use will be most beneficial, but we do advice to take proper care in producing the video-modelling, especially in choosing the model and providing additional instructions (e.g., see the website of Dutch Expertise Centre for Curriculum Development (SLO) and Section 4.2).

4.2. Deliverables: Website Dutch Expertise Centre for Curriculum Development (SLO)

Based on the present program of research (including pilot work leading up to the studies), it is important to use qualitatively well-produced video-models that help students to attend to relevant over salient information. The particular instructional features to be used to direct the students' attention, however, do not seem to be critical. We developed video-models using verbal explications and *eye movement modelling examples* (EMME) to be used for PE-teachers. We decided for including the EMME-feature, because this would be least accessible for PE-teachers, when they would produce video-models themselves.

Together with the Dutch Expertise Centre for Curriculum Development (SLO) we produced video-models for four activities: forward roll dismount from supported trapeze swing, far jump, javelin throw and volleyball overhand passing. For each activity, video-models were made for the levels basis, intermediate and advanced (i.e., skill-specific successful models). For each level, there is a male and a female model demonstrating the activity. The video-models for instruction and feedback are produced to fit in series of lessons that are developed by and made accessible via the website of the Dutch Expertise Centre for Curriculum Development (SLO)[3]. Apart from the SLO-website, the video-models are also available off-line through the app MijnGym[4]. Also an accompanying manual, further documentation and the present report are available from the SLO-website. They serve two purposes. Firstly, to offer insight for the PE-teacher in the underlying theoretical ideas and empirical support for using video-modelling in PE. Secondly, to offer guidelines to PE teachers for developing and producing their own video-models.

4.3 Deliverables: Workshops and presentations and papers

In the course of this project, several workshops and presentations were given about the project and the (preliminary) results. These workshops and presentations were directed to PE-teachers and other professionals and/or scientific audiences.

Overview presentations and workshops:

- Duivenvoorden, J. (2015). *Ontwikkelingen in praktijkgericht onderzoek*. Mini symposium at the 'Dag van het sportonderzoek'. Zwolle.
- Duivenvoorden, J. (2015). *Praktische thema's in motorisch leren*. Workshop, Carmel College Salland, Raalte.
- Duivenvoorden, J. (2016). *Praktische thema's in motorisch leren*. 'KVLO Studiedag Basisonderwijs'. Zwolle.
- Duivenvoorden, J. (2016). *Terugkijken met een tablet*. Symposium 'van Tikken naar Taggen'. Zwolle.
- Duivenvoorden, J. (2016). *Terugkijken met een tablet, de opbrengsten van de digitale gymles*. 'Kennisnet en NRO Onderzoeksconferentie'.
- Duivenvoorden, J. (2016). *Implicit motor learning in groups, and how TGfU may contribute*. 6th International TGfU Conference. Cologne, Germany.

[3] http://bewegingsonderwijs.slo.nl/themas/digitalisering-in-het-bewegingsonderwijs/digigym-leren-bewegen-met-een-tablet

[4] https://itunes.apple.com/nl/app/mijngym/id972093547?mt=8

- Duivenvoorden, J. (2016). *Video-instructie en feedback, zelfregulerend leren in het bewegingsonderwijs.* Workshop for PE teachers educators. Stenden Hogeschool, Leeuwarden.
- Duivenvoorden, J. & Schoffelmeer, L. (2016). *Terugkijken met een tablet.* Workshop during NRO congress 2016.
- Duivenvoorden, J. & Schakel, K. (2016). *Video-instructie en feedback, zelfregulerend leren in het bewegingsonderwijs.* Congres 'Meedoen met sport'.
- van der Kamp, J. (2015). *Digitale videofeedback en zelfsturing: Wat levert het op?* Workshop for PE-teachers during Van tikken naar taggen 2015, Zwolle.
- van der Kamp, J. (2016). *Trending topics in motorisch leren #Expliciet leren #Impliciet leren.* Van tikken naar taggen. Zwolle.
- van der Kamp, J. (2016). *Is there a proper role for instructions?* Physical Education and Sport Science Skill Symposium/9th Australasian Skill Acquisition Research Group meeting. Singapore.

At the time of completion of the project, a few papers leading into and based upon the current program of research have already been published; others are currently in preparation to be submitted to national and international journals.

Overview of papers:

- van der Kamp. J., Duivenvoorden, J., Kok, M., & van Hilvoorde, I. (2015). Motor skill learning in groups: Some proposals for applying implicit learning and self-controlled feedback. *Revista Internacional de Ciencias del Deport (International Journal of Sport Science), 11*, 33-47.
- Duivenvoorden. J., van der Kamp, J., & van Hilvoorde, I. (2016). Video-instructie en –feedback met een tablet. *Lichamelijk Opvoeding, 104,* 17-19.
- van der Zee, A. & van der Kamp, J. (2016). Het kiezen van videovoorbeelden voor digigym. *Lichamelijk Opvoeding, 104,* 52-54.

4.4 Deliverables: Education

The project directly contributes to the curriculum of the School for Physical Education (Calo) at the Windesheim University of Applied Sciences in Zwolle. Both practical (athletics, gymnastics, didactics) and theoretical (motor learning in bachelor and master course, innovations in physical education, research methods) courses are fed with the findings and products from *Video-modelling in Physical Education*.

Finally, during a practical masterclass, the PE teachers from partner schools were informed about the outcomes and products and trained to embed video-modelling in their classes. Further dissemination is planned through the website of the Dutch Expertise Centre for Curriculum Development (SLO), further workshops and articles in national and international professional and scientific journals. Keep an eye on it!

5. Literature

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