The effects of inducing mood and arousal through music before learning from an instructional video.

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Abstract

Instructional videos have become increasingly popular in elementary education. Educationalists have to make deliberate decisions while developing and selecting instructional videos. Therefore it is desirable to create research-based principles for instructional video designs (De Koning et al., 2018). This experiment therefore examined the effect of listening to music on the level of arousal, mood, and learning in children from the fifth and sixth grade of elementary school. All participants studied an instructional video in which they learned about the moon. Before the video, they listened to music that aimed to elicit a certain mood (positive or negative) and arousal (high or low). The manipulation of arousal was successful, post-music arousal scores significantly differed from pre-music arousal scores. However, this difference did not lead to different retention scores. The mood manipulation was unsuccesfull. Therefore, exploratory analyses were conducted; the effect of mood and arousal on retention was examined independently of the music conditions. Repeated measures ANOVAs found an effect of arousal and mood on retention. A repeated measures ANCOVA with mood as between subject factor and retention as within subject factor, with arousal as covariate, was nonsignificant. The effect of mood on retention only occurred when combined with higher arousal levels.

Video instruction

Online learning has prevailed in education. This development has its origins even before the COVID-19 pandemic, as a consequence of the trend of advanced technology (Kauffman, 2015). Video instruction is a popular component in online learning design. For example: video instruction is considered the primary source of instruction in massive open online courses (Hansch et al., 2015; Hollands & Tirthali, 2014). Instructional videos have proven to be beneficial for learning gains in different contexts. For instance, students at secondary schools had better retention after science classes with video instructions, compared to the traditional lessons (Achebe, 2008).

Instructors and educationalists have to make deliberate decisions while developing and selecting instructional videos, because of the diversity in courses regarding students, subject matters and learning objectives. Therefore it is desirable to create research-based principles for instructional video designs (De Koning et al., 2018; Hansch et al., 2015; Poquet et al., 2018). The main goal of this study is to contribute to the design principles of instructional videos for primary education. This study explores the effect of music-induced arousal and mood on retention. There is a reason to believe that background music would draw learners' attention away from the content of the video, and thereby impair learning of complex video material (Moreno & Mayer, 2000; Rey, 2012; Salamé & Beddeley, 1989). Therefore, this study focusses on the *priming* effect of music on learning gains: listening to music before the learning activity.

Mozart-effect

One reason why one might expect that listening to music prior to an instructional video would enhance the effectiveness of video learning comes from literature on the Mozart-effect. The Mozart-effect is an improved performance in spatial-temporal reasoning after

listening to Mozart's sonata (Pietschnig et al., 2010). Rauscher et al. (1993) found a temporary improvement of spatial reasoning abilities directly after listening to Mozart's sonata, compared to a control group which listened to a relaxation tape or waited in silence. The results of a meta-analysis revealed that the estimated effect size is small (d = 0.37, 95% CI [0.23, 0.52]) (Pietschnig et al., 2010). When comparing the Mozart-condition to another musical condition, the effect size becomes negligible: (d = 0.15, 95% CI [0.02, 0.28]). This suggests that the effect does not occur because of the composer, but because of the priming effect of music. The priming effect of music also arises for students' memory performance. Listening to music positively affects memory processes as recall exercises and recognition tasks (Hallam 2002, Nguyen & Gram, 2017).

Arousal-mood hypothesis

The *Arousal-mood hypothesis* details an explanation of the Mozart-effect. This hypothesis suggests that the positive learning effect is mediated by changes in *arousal* and *mood*, induced by the music (Husain et al., 2002; Thompson et al., 2001).

Moods can be described as affective states (Luomala & Laaksonen, 2000). Moods are viewpoints of the world, one's situation, and one's well-being (Parrott, 1993). Moods influence the access of different constructs in memory, and bias a persons' perceptions, judgements, evaluations and way of thinking (Luomala & Laaksonen, 2000). Music has also been considered as a powerful stimuli for certain moods. Previous studies concluded listening to music is an effective strategy for changing someone's mood (Silk et al., 2003; Thayer et al., 1994). Other studies even claim that regulating moods is the main reason to listen to music (Laiho, 2004; North et al., 2000; Sloboda & O'Neill, 2001).

Research on the effect of mood on memory tasks is well-established (Luomala & Laaksonen, 2000; Shen et al., 2019; Yuan & Shen, 2016). Previous research has distinguished two types of moods: spontaneous moods and experimentally induced moods (Shen et al., 2019). Spontaneous moods are non-manipulated moods: the participants' mood, existing before entering the experiment. Experimentally induced moods are moods which are created by manipulations. These two types of moods involve different neurocognitive mechanisms. Spontaneous moods activate the anterior cingulate cortex, which increases attention and cognitive control (Subramaniam et al., 2019). Experimentally induced moods activate the medial prefrontal cortex (Sakaki & Niki, 2011), which increases internally driven strategy shifts (Schuck et al., 2015; Yuan & Shen, 2016). Both mood constructs have an impact on recall tasks (Shen et al., 2019).

Arousal can be described as physical activation (Husain et al., 2002; Sloboda & Juslin, 2001). It is a state of physiological alertness and readiness for action (Sam, 2013). Arousal is regulated in the brain by the same neurotransmitters as cognitive functions as attention and memory (Ma et al., 2018). Mammarella et al. (2007) concluded that raised arousal levels led to higher performance on retention tests, because of increased attention while processing the learning materials.

Unlike the effect of mood on learning, Arousal affects task performance in a non-linear way. The *Yerkes-Dodson Law* claims that the effect of arousal on task performance is an inverted U-shape (Yerkes & Dodson, 1908). This means that too little or too much arousal impedes learning. Too little arousal implies an inactivated attitude, and a too high level of arousal implies stress because the participant is processing too much information (Faseur & Geuens, 2006). Moderate arousal however has a positive effect on memory performance (Diamond et al., 2007; Dutton & Carroll, 2001; Kleinsmith & Kaplan, 1963; Ochsner, 2000).

Mammarella et al. (2007) tested the arousal-mood hypothesis with memory tasks on healthy older adults. They concluded after a repeated-measure ANOVA that the music condition outperformed the white-noise and no-music condition on two different memory tasks. The best suited explanation was that the music caused attentional processes, resulting in improved performances on retention tests.

Nguyen and Grahn (2017) hypothesized that music stimulates participants' mood and arousal, which creates an optimal environment for memory performance. They created four musical conditions; high arousal positive mood music, high arousal negative mood music, low arousal positive mood music and low arousal negative mood music. Before starting the experiment, the participants (N=30) rated 150 music fragments to decide what music fits the different conditions. Nguyen and Grahn found a significant effect on arousal: the low-arousal music conditional group scored higher than the high-arousal music condition. No effect of mood on memory performance was found.

A limitation of former research is that many studies combined mood and arousal, to create two experimental groups (Anderson, Wais, & Gabrieli, 2006; Judde & Rickard, 2010; Liu, Graham, & Zorawski, 2008). To explore the effect of music-induced arousal and mood on retention, a distinction has to be made between the two constructs. There has been few experiments with primary school students. Only Hallam et al. (2002) tested the arousal-mood hypothesis with children (ages 10-12). However, Hallam et al. (2002) created just two experimental groups with arousal and mood combined as a variable, so no conclusions could be drawn of the different roles of the two constructs.

The present study

The purpose of this study is to provide empirical evidence for the arousal-mood hypothesis for retention of an instructional video for children from 8 to 10 years old. This

study builds upon previous research by Nguyen and Grahn (2017) and therefore only two arousal conditions are created, instead three conditions including ‘medium arousal’ the Yerkes-Dodson law suggests. This experiment contains four conditions: high arousal positive mood music (A+M+), high arousal negative mood music (A+M-), low arousal positive mood music (A-M+) and low arousal negative mood music (A-M-).

Research question: Does how much students learn from an instructional video depend on their level of arousal and mood?

Hypothesis 1: The A+ and M+ conditions have better retention of the content of the instructional video than the A- and M- conditions.

Hypothesis 2: The A+M- and A-M+ conditions have better retention scores than the A-M- condition, but less retention scores than the A+M+ condition

These expectations were written with findings of experiments in mind, which tested the effect of music-induced arousal and mood on memory performance (Hallam, 2002; Nguyen & Grahn, 2017; Mammarella et al., 2007). However, these studies did not find a significant effect of mood. Because the effect of mood on memory tasks is grounded in literature, it is expected to find an effect of mood on retention of the content of the instructional video (Luomala & Laaksonen, 2000; Shen et al., 2019; Yuan & Shen, 2016). After drawing conclusions on these hypotheses, several explorative analyses were conducted on sample level. For example: the effect of spontaneous moods on retention were tested, compared to experimentally induced moods.

Methods

Participants & design

This experiment had a 2x2 design, with arousal (high/low) and mood (positive/negative) as between-subject factors. This experiment contains four conditions: high arousal positive mood (A+M+), high arousal negative mood (A+M-), low arousal positive mood (A-M+), and low arousal negative mood (A-M-). After the mood and arousal manipulation, all participants took a pretest, then watched the instructional video, and finally took a posttest.

182 Dutch primary school students participated in the experiment. All participants were in their fifth or sixth year of primary education. A power analysis was conducted using G*power (version 3.1.9.4; Faul et al., 2009) with an expected effect size = .25 and power = .80, to define 179 as the required number of participants. The participants (N = 182) were randomly divided over the conditions. The precise division between A+M+, A+M-, A-M+, and A-M- conditional groups are shown in Table 1. The difference in the original number of participants in the A+M+ probably arose from misfollowing instructions during data collection. These children probably clicked on the wrong link before the start of the experiment. After deleting the incomplete data collections (N = 29) and deleting participants with negative retention scores (N = 13), the final dataset consisted of N = 140.

Table 1

Number of participants divided in the four experimental conditions

Condition	**Original number of participants**	**Incomplete data collections**	**Negative retention scores**	**Final number of participants**
A+M+	54	13	3	38

A+M-	41	5	2	34
A-M+	43	3	2	38
A-M-	44	8	6	30

At the time of the experiment, all participants had followed basic science lessons, but the content of this video instruction had not been taught yet, according to their teachers. The experiment took place in the participants' classroom, so the environment was similar to the familiar learning setting.

Materials

Music

To manipulate the participants' mood and arousal, the songs of the first experiment of Nguyen and Grahn (2017) were used. In this experiment fifteen students (mean age = 22.20) rated 150 music fragments on mood (positivity or negativity) and arousal. The rating scale ranged from -3 (very negative or low arousal) to 3 (very positive or high arousal). This scale contained 0 as a neutral option. The songs with the best fitting values for the condition were chosen. The songs and descriptives are shown in Table 2. These findings align with the conclusions of van der Zwaag et al. (2011), who stated that music with higher tempo induce higher levels of arousal. The songs used to create high levels of arousal have a higher tempo than the low arousal conditions. Husain et al. (2002) claimed that music in minor mode induced a negative mood, like the music by Frédéric Chopin which Nguyen and Grahn concluded to be suitable to induce a low level of arousal and a negative mood.

The length of the music fragments was set at 3 minutes. The A-M+ condition song was played 1.5 times to fill the length of the music fragment. Both the A-M+ and A-M- conditions listened to instrumental music, the A+M+ and A+M- conditions listened to music with vocals. This difference in music features has an effect when using it as background music, because verbal information is processed firstly when competing with visual/spatial information, at the expense of cognitive resources (Salamé & Baddeley, 1989). In this experiment this difference is assumed to not be relevant because the participants listened to the music prior to the learning activity, so the information is not competing at the same time.

Table 1

List of songs and descriptives on Arousal and Mood in the Nguyen and Grahn (2017) study.

Condition	**Song**	**Mean Arousal**	**SD Arousal**	**Mean Mood**	**SD Mood**
High Arousal, positive mood	Ghost N Stuff - Deadmau5	2.47	1.13	2.13	.99
High arousal, negative mood	Burn - Apocalyptica	1.93	1.49	-1.27	1.53
Low arousal, positive mood	You'd be so nice to come home to - Cole Porter	-1	1.58	1.07	1.41
Low arousal, negative mood	Prelude In E Minor (Op. 28: No. 4) Frédéric Chopin	-1.73	0.7	-1.93	1.34

Mood and arousal

Two questionnaires of the Brengman (2004) PAD-scale were used to measure mood and arousal. This questionnaire consists of six questions for each construct, which are answered with a 7-point Likert scale. Meesschaert (2006) translated this questionnaire to Dutch and tested the validity of this instrument with a Principal Component Factor Analysis, using university students as participants. After a Varimax rotation, Meesschaert concluded that these 12 questions measured the two different constructs. Together the components explained 54% of total variation, and the Cronbach's Alpha measured .882 (mood) and .748 (arousal). To ensure that the 8 to 12 year olds would be able to understand the questions, a verbal explanation of the words was provided during this phase of the experiment. This verbal explanation was applied the same way during each data collection.

Meesschaert's (2006) questionnaire consisted of two opposite emotion terms, between which the participants had to take a position. This form was not supported by the Qualtrics software. As a result, the extent to which each emotion term applied to the participant's feelings was separately questioned. This adaptation created items that questioned low arousal or negative mood. These items are reversed, and an R was added to the number in the designation. Items 1R, 2, 5R, 6, 7R, 8, 15R, 16, 17R, 18, 21R, 22 of the questionnaire measured 'mood' and item 3R, 4, 9R, 10, 11R, 12, 13R, 14, 19R, 20, 23R, 24 measured 'arousal'. The complete questionnaire was added in Appendix 2.

To measure the reliability of the used questionnaires for spontaneous and manipulated mood and arousal, Cronbach's alpha was calculated (Field, 2018). To reach a conclusion about the rating of alpha, the rule of thumb of George and Mallery (2003) was used. The rule of thumb by George and Mallery (2003) assesses a measurement tool with a Likert scale. The ratings and corresponding alpha values are shown in Table 2. After calculating Cronbach's

alpha, the calculated alpha if deleted was used to consider whether relevant question should be removed from the questionnaire. If removing an item causes the questionnaire to receive a better rating according to the rule of thumb, that item is removed from the questionnaire.

Table 2

Cronbach's alpha values and associated ratings by George and Mallery (2003)

Cronbach's alpha	**Rating**
$\alpha \geq .90$	Excellent
$.90 \leq \alpha < .80$	Good
$.80 \leq \alpha < .70$	Acceptable
$.70 \leq \alpha < .60$	Questionable
$.60 \leq \alpha < .50$	Poor
$\alpha \leq .50$	Unacceptable

Source: George and Mallery (2003)

The questionnaire measuring spontaneous mood had an acceptable reliability (α = .705) and the spontaneous arousal questionnaire had a questionable reliability after deleting reversed item 9 (α = .665), before deleting i9 the internal consistency measured poor (α = .591). Item 9 required participants to indicate the extent to which the word "calm" matched their state of mind. The manipulated mood questionnaire had a good internal consistency (α = .809), the manipulated arousal questionnaire had a near acceptable reliability (α = .696) after

deleting item 19 (α = .635). In item 19, the word *languid* was questioned, with the verbal explanation being "slow, sluggish".

Table 2

Brengman (2004) Questionnaire for 'mood' and 'arousal', translated to Dutch by Meesschaert (2006)

1 (mood)	Bedrukt	-3	-2	-1	0	1	2	3	Aangenaam
2 (arousal)	Ontspannen	-3	-2	-1	0	1	2	3	Gestimuleerd
3 (mood)	Ongelukkig	-3	-2	-1	0	1	2	3	Gelukkig
4 (mood)	Ontevreden	-3	-2	-1	0	1	2	3	Tevreden
5 (arousal)	Rustig	-3	-2	-1	0	1	2	3	Opgewonden
6 (arousal)	Slaperig	-3	-2	-1	0	1	2	3	Wakker
7 (arousal)	Niet geprikkeld	-3	-2	-1	0	1	2	3	Geprikkeld
8 (mood)	Geërgerd	-3	-2	-1	0	1	2	3	Behaaglijk
9 (mood)	Verveeld	-3	-2	-1	0	1	2	3	Ontspannen
10 (arousal)	Loom	-3	-2	-1	0	1	2	3	Uitzinnig

11 (mood)	Wanhopig	-3	-2	-1	0	1	2	3	Hoopvol
12 (arousal)	Futloos	-3	-2	-1	0	1	2	3	Zenuwachtig

Instructional Video

An instructional video of the knowledge of the moon and space traveling was used from Schooltv Beeldbank by NTR: Schooltv: Nieuws uit de Natuur - De maan. This video was chosen because of the likability of low prior knowledge so retention can be properly measured. The duration of the video was 14:04 minutes. The duration is important because the effect of arousal is expected to occur by attention. When the video is too short, this effect could not be visible because all participants still have the required attention span. This video was classified for children from aged seven to twelve by Schooltv Beeldbank.

Pretest and posttest

To measure retention, a pretest and a posttest were conducted. Both tests consisted of the same 19 multiple choice questions. The questions covered the content instructional video, and were created by a 5th grade primary school teacher. An example of a test question is: "Why can it get very hot on the moon? a. Because the moon is always closer to the sun b. Because the sun shines longer on the moon c. Because there is no water on the moon d. Because the moon has no atmosphere". The Dutch questions can be found in Appendix 1.

To measure the reliability of this test, Cronbach's alpha was calculated (Field, 2018), and the rule of thumb of George and Mallery (2003) was used as a guideline for interpretation. Regarding the test scores, the calculated Cronbach's alpha showed a low internal consistency in the pretest items (α = .173). One explanation is that the participants

had little prior knowledge. The probability of guessing a question correctly is 25%, so when all 19 questions are guessed, the pretest score will come out to 4.75. The mean score of the pretest is 5.33, making it likely that participants completed the pretest guessing. The pretest scores are shown in Table 5.

The posttest's reliability was questionable (α = .633). According to the Cronbach's alpha scores if the item was deleted, deleting items from the questionnaire did not change the rating of reliability by George and Mallery (2003).

Procedure

Before joining the research, the participants and their legal caretakers signed an informed consent. At school A and B, the children were given two information letters to take home; one written for adults and one written for the children in simpler language. They handed in these letters signed to the teacher, who then turned the consent letters over to the researcher. At one of the schools, the management did not agree to this procedure because of the added workload for the teachers. At this school, legal caretakers received the same information letters by mail, along with a link to the Qualtrics questionnaire in which they could give consent for their child to participate. In the informed consent letters the goal of the study and the way of measuring was explained. These letters described that participation in the study is voluntary, and that there are no consequences for not participating or stopping the study early. The children who did not participate in the study worked on their school work during the data collection.

The participants were tested individually. A laptop and headphones were prepared in their own classroom. The participants were told that they can pause the experiment at all times, to drink some water, or to use the restroom. At first, the participants filled in the

questionnaires of mood and arousal in Qualtrics questionnaire software. Afterwards, the pretest was presented. Then, all participants listened to the music fragment depending on their condition Afterwards, the mood and arousal questionnaires were filled in again, to test if the manipulation was successful.

Thereafter, the participants were instructed to watch the instructional video. The participants were told to be quiet while doing so, to make sure the other participants were not interrupted. Each condition watched the same video. In the end, the posttest was filled in so the retention scores could be calculated. When finished, the participants were asked to wait and read a book of choice quietly until everyone was done, to ensure that all students could complete the experiment without being interrupted by others.

Analysis

At first the mean and standard deviation were calculated for the arousal and mood measures from before and after the manipulation, per experimental group. Each individual had a before-music score for mood and arousal: spontaneous mood/arousal, and an after-music score for mood and arousal: manipulated mood/arousal.

Then, a manipulation check was performed. Two ANCOVA's were used to check if the music manipulated arousal and mood in the expected way. Beforehand, the assumptions of homogeneity of regression and variety of the covariate were tested. To examine the effect of the music fragments on mood, an ANCOVA was conducted with mood conditions (positive/negative) as the between-subject factor, manipulated mood as the dependent variable, and spontaneous mood as covariate. The same way, the effect of the music fragments on arousal was examined with an ANCOVA with arousal conditions (high/low) as the between-subject factor, manipulated arousal as the dependent variable, and spontaneous arousal as covariate.

After testing the manipulation, the effects of arousal and mood on retention were examined. Participants with a score of 17, 18, or 19 on the pretest were not considered in the analysis. When the score on the pretest is so high, the instructional video will not be suitable for measuring retention: participants knew many answers before watching the instructional video. Participants with negative retention scores were also not considered in the analysis. When participants have a negative retention score, this should be interpreted as that knowledge was deflated after watching the instructional video. This is not a realistic representation of retention. The complete dataset for retention scores consisted of $N = 140$, after deleting the incomplete data collections ($N = 29$) and deleting participants with negative retention scores ($N = 13$). Division of remaining participants per experimental groups are shown in table 3.

Table 3

Number of participants divided in the four experimental groups

Condition	**Incomplete data collections**	**Negative retention scores**	**Final number of participants**
A+M+	13	3	38
A+M-	5	2	34
A-M+	3	2	38
A-M-	8	6	30

Then the normality, the homogeneity of variance, and the outliers of the four conditions were checked. Then, two standard repeated measures ANOVA were conducted, with arousal (high/low) and mood (positive/negative) as between subject variables and

retention as within subject variable. For further exploration, a standard repeated measures ANCOVA was conducted with arousal (high/low) and mood (positive/negative) as between subject variables, and retention as within subject variable, with arousal as covariate. Afterwards, the same ANCOVA was performed, but with mood as covariate. The effect of arousal and mood on retention, distinct from the experimental groups, were also explored. All hypothesis tests used $\alpha = .05$ for significance.

Results

Descriptives were calculated of the A+M+, A+M-, A-M+, and A-M- experimental groups. The means and standard deviations are shown in Table 4. The descriptives of arousal and mood are the data after listening to the music fragments. The scale of arousal and mood scores of arousal is between 0 and 36. The scale of pretest and posttest is between 0 and 19.

Table 4

Descriptives of arousal and mood after listening to the music fragments, pretest scores and posttest scores, by experimental group.

Experimental group	**Mean arousal**	**SD arousal**	**Mean mood**	**SD mood**	**M pretest**	**SD pretest**	**M posttest**	**SD posttest**
A+M+	9.58	11.57	16.50	12.46	5.50	2.21	10.37	3.04
A+M-	8.76	12.39	15.38	15.82	5.53	1.81	11.32	3.11
A-M+	2.06	9.27	13.50	14.91	5.29	2.05	10.53	3.25

A-M-	2.77	10.81	14.97	14.97	4.93	1.74	9.90	2.75
All combined	6.11	11.54	15.26	13.92	5.33	1.97	10.54	3.06

Manipulation check

First, the experimental groups were combined to create the conditions. The A+M+ and A+M- groups combined to create the high arousal condition, the A-M+ and A-M- groups were combined to create the low arousal condition. The A+M+ and A-M+ groups together became the positive mood condition, and the A+M- and A-M- groups together created the negative mood condition. Descriptive statistics of spontaneous arousal, manipulated arousal, spontaneous mood and manipulated mood were calculated, for the arousal conditions (high/low) and mood conditions (positive/negative). These descriptives are shown in Table 5. Two ANCOVAs were used to check whether the music has the desired effect on levels of arousal and mood. The first ANCOVA examined the difference in arousal levels between the A+ and A- conditions, corrected on the participants' arousal level before being exposed to the music of their experimental group. The second ANCOVA examined the difference for the mood variable, with spontaneous mood as covariate. At first, the assumptions for ANCOVA analysis were verified for both the arousal and mood variables. These assumptions were met. The manipulation check on arousal was significant, $F(1,130) = 12.054$, $p < .001$, partial $\eta^2 = .089$. The manipulation check on mood was non-significant, $F(1,130) = .155$, $p > .05$, partial $\eta^2 = .001$.

Table 5

Descriptives of arousal and mood by condition. Spontaneous arousal and mood is from the data collection prior to manipulation, manipulated arousal and mood are the values after listening to the music fragments.

Condition	***N***	**M spontaneous arousal**	**SD spontaneous arousal**	**M manipulated arousal**	**SD manipulated arousal**
High arousal (A+M+ & A+M-)	72	6.29	9.93	9.19	11.89
Low arousal (A-M+ & A-M-)	68	4.46	11.30	2.46	10.04
		M spontaneous mood	**SD spontaneous mood**	**M manipulated mood**	**SD manipulated mood**
Positive mood (A+M+ & A-M+)	76	15.21	11.60	15.33	13.61
Negative mood (A+M- & A-M-)	64	16.67	10.34	15.19	14.36

Because the manipulation for the mood condition was not successful, the planned analysis to examine the effect of mood on retention was extended to include an exploratory analysis. This exploratory analysis was a repeated measures ANOVA with manipulated mood

as the between subject factor and the pretest and posttest as the within subject factor. The last mood measurement before the pretest was made was taken for the between subject factor.

Retention

The means and standard deviations of the pretest and posttest were calculated for each condition. These data are shown in Table 6. A repeated measures analysis with pretest scores and posttest scores as within subject factor, showed a main effect of test moment, $F(1,136) = 410.004$, $p < .001$, partial $\eta^2 = .751$. This means that the pretest and posttest test scores differed, the participants were more successful in completing the test questions after watching the instructional video.

Table 6

Pretest scores and posttest scores by condition

Condition	N	M pretest	SD pretest	M posttest	SD posttest
High arousal (A+M+ & A+M-)	72	5.51	2.02	10.82	3.09
Low arousal (A-M+ & A-M-)	68	5.13	1.92	10.25	3.03
Positive mood (A+M+ & A-M+)	76	5.39	2.12	10.45	3.13
Negative mood (A+M- & A-M-)	64	5.25	1.79	10.66	3.01

To examine the hypothesis that the A+ and M+ conditions have better retention of the content of the instructional video than the A- and M- conditions, a repeated measures ANOVA was performed. At first, the assumptions of conducting a repeated measures ANOVA were confirmed. Results showed no significant main effect of mood on retention, $F(1,138) = .474$, $p > .05$, partial $\eta^2 = .003$. This means that the increase in test score was not significantly higher for participants in the positive mood conditions (M = 5.05, SD = 3.22) than those in the negative mood conditions (M = 5.41, SD = 2.78). There also was no main effect of arousal on retention, $F(1,136) = .198$, $p > .05$, partial $\eta^2 = .001$. This means that the increase in test score was not significantly higher for participants in the high arousal conditions (M = 5.31, SD = 3.12) than those in the low arousal conditions (M = 5.12, SD = 2.94).

To examine the hypothesis that the A+M- and A-M+ conditions have better retention scores than the A-M- condition, but less retention scores than the A+M+ condition, the interaction effects between arousal and mood on retention scores were analyzed. No interaction effect was found between the arousal condition (high/low) and the mood condition (positive/negative) on retention scores, , $F(1,136) = 1.347$, $p > .05$, partial $\eta^2 = .010$. This implies that the combination of arousal and mood conditions had no effect on retention scores.

Exploratory analyses

Several exploratory analyses were conducted to explore the effect of arousal and mood on retention, distinct from the experimental conditions. The manipulated mood and arousal scores, the score after listening to the music fragments, represented the arousal and mood constructs in these analyses. This decision was made because these measurements were the closest in time to the pre- and posttest.

A repeated measures ANOVA with manipulated arousal as between subject factor and pretest and posttest as within subject factor, found an effect of manipulated arousal on retention scores as well, F (43,89) = 1.627, p <.05, partial η^2 = .440. This means that participants with higher arousal scores, better retention scores. A repeated measures ANOVA with manipulated mood as between subject factor and pretest and posttest as within subject factor, also showed a significant effect of manipulated mood on retention scores, F (45,87) = 1.545, p <.05, partial η^2 = .444. This means that the participants who indicated a more positive mood had better retention scores.

The relationship between these two predictors was further explored. A correlation was found between manipulated mood and manipulated arousal, r (133) = .463, p < .001. A repeated measures ANCOVA with manipulated mood as between subject factor and pretest and posttest as within subject factor, and with manipulated arousal as covariate, showed no significant effect, F (45,86) = .908, p >.05, partial η^2 = .322. Thus, participants with a more positive mood are more likely to have higher arousal scores. The effect of a positive mood on retention is present only when combined with higher arousal levels.

Discussion

Instructional videos have become increasingly popular in elementary education. Educationalists have to make deliberate decisions while developing and selecting instructional videos. Therefore it is desirable to create research-based principles for instructional video designs (De Koning et al., 2018; Hansch et al., 2015; Poquet et al., 2018). The main goal of this study is to contribute to the design principles of instructional videos for primary education. This experiment therefore examined the effect of listening to music on the level of arousal, mood, and learning in children from grade 5 and grade 6 of elementary school. All participants studied an instructional video in which they learned about the moon. Before the

video, they listened to music that aimed to elicit a certain mood (positive or negative) and arousal (high or low).

The results showed that the arousal manipulation was successful: a significant difference was found in arousal levels between the high and low arousal conditions. This difference was corrected on spontaneous arousal, arousal scores before listening to the music. The manipulation check on mood tested nonsignificant. Even though the arousal music manipulations were successful, these manipulations did not lead to higher retention scores in the high arousal experimental group.

The results showed no significant difference in retention between the arousal experimental groups (high/low), as well as for the mood experimental groups (positive/negative). Although, when the data was analyzed separately from the experimental groups, there is a significant effect of manipulated mood and manipulated arousal on retention scores. The analysis of manipulated mood on retention scores indicates that there is no effect when corrected for manipulated arousal. Conclusion: levels of arousal have an effect on retention scores when watching a video. The data showed an effect of mood on retention scores, moderated by arousal.

These findings are consistent with the conclusion of Mammarella et al. (2007). Mammarella et al. (2007) concluded that raised arousal levels led to higher performance on retention tests, because of increased attention while processing the learning materials. Another similarity is that in both studies no effect of mood on retention was found. The main difference between this study and Mammarella's study is the population and the manipulation. Instead of healthy older adults, this study focuses on elementary school students. In Mammarella's study, three conditions were compared: one group listened to music, another group listened to white noice and the last group made the memory task in silence.

Nguyen and Grahn (2017) neither found an effect of mood on memory performance. They have found a significant effect on arousal: the low-arousal music conditional group scored higher than the high-arousal music condition. This conclusion contradict the results of the exploratory analyses of this study. The design of the Nguyen and Grahn study was very similar to this experiment, but the main differences were that both their manipulations were successful, and the music was played during the memory task rather than before the task. The difference in findings can be explained by the timing of the music: there is a reason to believe that background music would draw learners' attention away from the content of the video, and thereby impair learning of complex video material (Moreno & Mayer, 2000; Rey, 2012; Salamé & Beddeley, 1989).

Strengths and limitations

A strength of this research is its social relevance. The topic of this research has the potential to make a lot of impact on daily practice in elementary schools. A simple modification such as playing music as an introduction can make a big difference as instructional videos are increasingly used in classrooms. Because this experiment was conducted in the students' own classroom, the situation is very similar to the normal context in which the children watch the instructional videos. This makes this study ecologically valid. Besides, very little research has been done on children's learning from instructional videos, even though this is the target audience that engages a lot with videos. This occurs with children both in their spare time and as part of formal lessons. Despite its limitations, this research has social relevance because it links existing knowledge about music in video learning to this population.

One of these limitations is the effect of the music on mood and arousal. The music fragments caused no differences between the groups on mood, and the difference of arousal

was very small (partial η^2 = .089). Probably as a result, there was no difference in retention scores between the mood conditions (positive/negative) and arousal conditions (high/low). The music fragments were found to cause significant differences in mood and arousal in the study by Nguyen and Grahn (2017), but this study was conducted with adults. The difference in population may explain the difference of the effect of music on mood and arousal. In the future, this can be avoided by conducting the experiment in two parts: in the first part, the participants listen to different music fragments, with a measurement of arousal and mood after each fragment. In the second part, the participant makes a pretest, then listens to the music fragment with the optimal composition of mood and arousal, after which the instruction video is watched, and the posttest is made.

A limitation of this study is the reliability of the questionnaires. The reliability of the questionnaire measuring spontaneous mood was acceptable (α = .705), the spontaneous arousal questionnaire was questionable (α = .665), the manipulated mood questionnaire was good (α = .809), and the manipulated arousal questionnaire was near acceptable (α = .696). In previous research, the mood and arousal questionnaire showed good internal consistency. An explanation for the different values of the Cronbach's alpha may be that this study was conducted with a different population. Because this experiment was conducted with children in the fifth and sixth grade of primary schools, the questionnaire was explained verbally. However, this was not sufficient to make the measurement instrument suitable; the items should be adapted to the vocabulary of Dutch children in the fifth and sixth grade of elementary school. It is recommended that future research creates a reliable measurement instrument to measure the arousal and mood of this specific population.

Nevertheless, there are reasons to take the results of these questionnaires seriously. Nunnally (1978) states that a Cronbach's alpha of .5 will be sufficient for research *in early*

stages. Because so little research has been done within this population on the effect of arousal and mood on retention, this study belongs to this category.

The internal consistency of the pretest was unacceptable (α = .173). One explanation is that the participants had little prior knowledge. The probability of guessing a question correctly is 25%, so when all 19 questions are guessed, the pretest score will come out to 4.75. The mean score of the pretest is 5.33, making it likely that participants completed the pretest guessing. The pretest is designed to measure participants' prior knowledge before watching the video, low internal consistency is not a flaw for the practical usefulness of this questionnaire. It is simply an indication of diversity in the difficulty of the questions.

Interestingly, nearly 16% of the participants did not complete all parts of the experiment. One explanation may be that the experiment took too long for the attention span of some of the participating children. The aforementioned verbal explanation during the taking of the arousal and mood questionnaire caused the experiment to take longer than expected. Moreover, this made it impossible to complete the initial questionnaires at one's own pace. Another explanation for this percentage of unfinished experiments is that one or more tasks did not match the children's interests. Because a large number of participants did not complete the experiment, the final sample size (N=140) was lower than the intended sample size (N=182). As a result, this study was underpowered. Moreover, it is likely that the participants who had difficulty with the tasks quit the experiment without finishing. This could cause the lower scores to be less represented in the data, ultimately affecting the results.

Future recommendations and use for education

Few studies have been done on the effect of music on learning through instructional videos of children in the fifth and sixth grade of elementary school. Because of this, it is desirable to further investigate this phenomenon in this population before major adjustments

are made in education. It is recommended that future research should develop a mood and arousal questionnaire for Dutch children in this age group. In this way, the roles of both psychological constructs can be better examined. Thereby, the effect of different music samples in this population can be better investigated. It is also advisable to find out which pieces of music most affect the mood and arousal levels of children of this age. This current study adopted the music samples from Nguyen and Grahn (2017) because they were found to be effective in their study. However, the manipulation on mood was not successful in this population. By testing different music fragments beforehand, it can be determined if music that is more appropriate to children's perceptions will have a larger effect on their mood and arousal. If a larger effect is found, perhaps the effect of arousal on retention will become apparent after a music manipulation.

Despite the limitations there are two recommendations for practice, based on the results of this study. First, certain styles of music influence children's arousal levels. Music can be used in the classroom to make children more alert or calm. Conversely, teachers who play music in the classroom should be aware of its effects on their students' levels of arousal. Second, a significant effect of arousal on retention was found independent of the experimental conditions. What this means for practice is that listening to the music associated with the high arousal groups has no effect. However, the level of arousal does have an effect on retention ($\eta 2 = .440$). Teachers may decide to schedule an instructional video with retention as a goal at a time when the class show high arousal. This can also be used the other way around; when a class demonstrates a low level of arousal, teachers may choose to postpone a scheduled instructional video to a time when the children demonstrate more arousal.

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Appendix 1: pretest and posttest questions.

1. Hoe kan je de maan goed bekijken?
    a. Met een verrekijker
    b. Met een microscoop
    c. Met een telescoop
    d. Met een endoscoop
2. Hoe kwamen ze vroeger aan kennis over de maan?
    a. Ze keken ’s nachts heel goed en maakten video-opnames
    b. Ze keken ’s nachts heel goed en maakten aantekeningen
    c. Ze keken overdag en ’s nachts heel goed en maakten video-opnames
    d. Ze keken overdag en ’s nachts heel goed een maakten aantekeningen
3. Wat hebben sterrenkundigen al ontdekt door goed naar de maan te kijken?

a. Dat de aarde om de maan draait, en de aarde om de zon

b. Dat de maan om de aarde draait, en de aarde om de zon

c. Dat de aarde om de zon draait, en de maan om de zon

d. Dat de zon om de aarde draait, en de maan om de aarde

4. Waarom kunnen wij op aarde de maan zien?

    a. Omdat de zon licht schijnt dat door de maan weerkaatst wordt

    b. Omdat de zon licht schijnt dat door de aarde weerkaatst wordt en op de maan terecht komt

    c. Omdat de maan licht schijnt dat op de aarde terecht komt

    d. Omdat de aarde licht schijnt dat op de maan terecht komt

5. Wanneer is er een ‘nieuwe maan’?

    a. Wanneer er een nieuwe maand is

    b. Wanneer er een nieuw seizoen is

    c. Als je vanaf de aarde de nieuwe kant van de maan ziet

    d. Als je op aarde bijna niks van de maan ziet

6. Wat hebben we aan de maan te danken?

    a. De seizoenen

    b. Het licht in de nacht

    c. De telling van de dagen

d. De telling van de jaren

7. Hoeveel groter is de aarde dan de maan?

    a. De aarde is 2x zo groot als de maan

    b. De aarde is 4x zo groot als de maan

    c. De aarde is 6x zo groot als de maan

    d. De aarde is 8x zo groot als de maan

8. Hoe zijn de kraters op de maan ontstaan?

    a. Omdat rotsblokken uit de ruimte op de maan zijn gebotst

    b. Omdat de maan ontstaan is uit een stuk aarde, dat niet glad was

    c. Omdat er vulkanen uitgebarsten zijn op de maan

    d. Omdat er aardbevingen zijn op de maan

9. Wat voor namen hebben de kraters op de maan?

    a. Namen van meisjes

    b. Namen van jongens

    c. Namen van gebergten

    d. Namen van zeeën

10. Welke landen hebben 60 jaar geleden veel onderzoek gedaan naar de maan?

    a. Amerika en Rusland

    b. Amerika en China

c. Nederland en China

d. Amerika en Nederland

11. Waarom kan het op de maan heel heet worden?

a. Omdat de maan altijd dichter bij de zon is

b. Omdat de zon langer schijnt op de maan

c. Omdat er geen water is op de maan

d. Omdat de maan geen dampkring heeft

12. Hoe zorgen ruimtepakken dat het lichaam van een astronaut koel blijft?

a. Met icepacks die erin genaaid zitten

b. Met een isolatielaag

c. Met water dat erdoorheen gepompt wordt

d. Doordat de stof van speciale kunststof gemaakt is

13. Waarom kunnen astronauten moeilijker bewegen op de maan?

a. Omdat de ruimtepakken een stijve laag heeft, die de astronaut tegen de luchtdruk beschermt

b. Omdat er meer zwaartekracht is op de maan

c. Omdat er op de maan minder zuurstof is, wat nodig is om te kunnen bewegen

d. Omdat de astronauten al erg moe zijn van de lange ruimtereis

14. Waarom is het gevaarlijk als je op de maan achterover valt?

a. Omdat je dan de ruimte in kan zweven

b. Omdat in je rugzak kapot kan gaan, waarin je water en zuurstof zit.

c. Omdat er geen EHBO-koffer op de maan is

d. Omdat je op de maan harder valt dan op de aarde, door de zwaartekracht

15. Waarom zijn er sinds 1972 geen mensen op de maan geweest?

a. We weten alles al, dus er wordt geen onderzoek meer gedaan

b. Er is een ongeluk gebeurd waardoor het verboden is

c. Er is geen geld voor, de reizen zijn te duur

d. Er zijn geen goede raketten meer gebouwd

16. Hoe groot zijn ruimtesattelieten tegenwoordig (apparaten die voor onderzoek de ruimte in geschoten worden)?

a. Zo groot als een auto

b. Zo groot als een koelkast

c. Zo groot als een stoel

d. Zo groot als een melkpak

17. Hoe komt een sattelieten (apparaten die voor onderzoek de ruimte in geschoten worden) aan brandstof?

a. Ze hebben een benzinetank

b. Ze maken gebruik van zonne-energie

c. Ze maken gebruik van windenergie

d. Ze maken gebruik van kernenergie

18. Waarom willen onderzoekers zo graag naar de andere kant van de maan?

    a. Omdat je vanaf daar heel ver de ruimte in kan kijken

    b. Omdat we de kraters daar nog in kaart moeten brengen

    c. Omdat we verwachten dat daar buitenaards leven is

    d. Omdat we daar de temperatuur willen onderzoeken

19. Waarom moet je heel goed opletten als je met satellieten werkt?

    a. De kans is groot dat hij kapot kan gaan in de ruimte

    b. Je moet goed in de gaten houden waar hij naartoe zweeft in de ruimte

    c. De kans is groot dat je een nieuwe planeet of ster ontdekt

    d. Hij komt maar één keer in de zoveel tijd langs jouw plek op aarde

Appendix 2: Questionnaire Meesschaert (2006) with Dutch explanations of the feelings.

1 (mood R)	Bedrukt (gespannen, druk voelen)	-3 -2 -1 0 1 2 3
2 (mood)	Aangenaam	-3 -2 -1 0 1 2 3

3 (arousal R)	Ontspannen	-3	-2	-1	0	1	2	3
4 (arousal)	Gestimuleerd	-3	-2	-1	0	1	2	3
5 (mood R)	Ongelukkig	-3	-2	-1	0	1	2	3
6 (mood)	Gelukkig	-3	-2	-1	0	1	2	3
7 (mood R)	Ontevreden	-3	-2	-1	0	1	2	3
8 (mood)	Tevreden	-3	-2	-1	0	1	2	3
9 (arousal R)	Rustig	-3	-2	-1	0	1	2	3
10 (arousal)	Opgewonden	-3	-2	-1	0	1	2	3
11 (arousal R)	Slaperig	-3	-2	-1	0	1	2	3
12 (arousal)	Wakker	-3	-2	-1	0	1	2	3

13 (arousal R)	Niet geprikkeld	-3	-2	-1	0	1	2	3
14 (arousal)	Geprikkeld (geactiveerd)	-3	-2	-1	0	1	2	3
15 (mood R)	Geërgerd	-3	-2	-1	0	1	2	3
16 (mood)	Behaaglijk (fijn, rustig, prettig)	-3	-2	-1	0	1	2	3
17 (mood R)	Verveeld	-3	-2	-1	0	1	2	3
18 (mood)	Ontspannen	-3	-2	-1	0	1	2	3
19 (arousal R)	Loom (Langzaam, sloom)	-3	-2	-1	0	1	2	3
20 (arousal)	Uitzinnig (erg blij, hyperactief)	-3	-2	-1	0	1	2	3

21 (mood R)	Wanhopig	-3	-2	-1	0	1	2	3
22 (mood)	Hoopvol	-3	-2	-1	0	1	2	3
23 (arousal R)	Futloos	-3	-2	-1	0	1	2	3
24 (arousal)	Zenuwachtig	-3	-2	-1	0	1	2	3

Appendix 3: Assignment 4

Week	**planning**	**done**
3 (1 dec)	Outline introduction	
4 (8 dec)	**Introduction done** Outline methods Assignment Peer Feedback 2	
5 (15 dec)	Draft version of research plan done **Methods done** (including analyses)	

6 (22 dec)	Presentation Assignment 3	
christmas	Draft version of research plan scanned on writing style & quality. **Deadline draft version 10 jan** (BB safe assign.)	
7 (12 jan)	Process teacher feedback Assignment 4: **FERB-application**	
8 (19 jan)	Give peer feedback : Assignment Peer Feedback 3 Focus on the coherence in your research plan: do constructs in Introduction and Method align? Does the method fit the research question? Do the analyses fit the data and the research question?	
deadline 30-01-2022		**FERB-application**
Date	**Meeting**	**Planned done**

9 februari	Meeting 1: Kick off Thesis From plan to thesis: recruiting participants and developing instrumentation	**Assignment 1**
23 februari	Peer feedback (schedule on your own)	**Recruiting participants done** **Developing instrumentation done**
9 maart	Meeting 2: Round Tables	Assignment 2 **Start experiment**
6 april	Meeting 3: Supervision	Assignment 3 **Finish experiment & perform analyses**
4 mei	Meeting 4: Supervision	Assignment 4 **Write results**
11 mei	Peer feedback (schedule on your own)	**Write discussion**
18 mei		DEADLINE Draft version thesis

25 mei	Meeting 5: Supervision + teacher feedback	
1 juni	Peer feedback (schedule on your own) Practise presentations	Assignment 5 **Processing teacher feedback**
10 juni		DEADLINE Final Master's thesis Submit final version of Master's thesis and SCROL form on Blackboard via Urkund (see instructions below) Submit data package (see instructions for submitting data package on Blackboard), Assignment 6 **10 – 14 juni: Make presentation thesis conference**
15 juni	Master's thesis conference	
11 juli		DEADLINE If applicable: Reassessment Submit on Blackboard via Urkund

Appendix 4: informed consent letters

Informatiebrief voor deelname aan (sociaal)-wetenschappelijk onderzoek
Music priming instructional videos; the mediation effect of arousal and mood on learning gains

Beste ouder(s), verzorger(s),

Door middel van deze brief vraag ik uw toestemming voor deelname van uw kind aan wetenschappelijk onderzoek. Het onderzoek zal plaatsvinden op school. Dit onderzoek is getoetst en goedgekeurd door de Facultaire Ethische Toetsingscommissie (FETC) van de Faculteit Sociale Wetenschappen van de Universiteit Utrecht en voldoet aan de ethische richtlijnen.

Meedoen door uw kind is vrijwillig en u en/of uw kind kan te allen tijde stoppen zonder dat u, hij/zij daar een reden voor hoeft te geven. Daar zullen voor u geen gevolgen aan verbonden zijn. Voordat u beslist of uw kind mag meedoen aan dit onderzoek, zullen we u in deze brief informeren over wat het onderzoek inhoudt. Lees deze informatie rustig door en vraag de onderzoeker om uitleg als u vragen heeft .

Doel van het onderzoek

De laatste jaren is de relevantie van instructievideo's steeds zichtbaarder geworden. In het thuisonderwijs en in de klaslokalen wordt er steeds meer gebruik gemaakt van dit hulpmiddel. Veel video's zijn echter niet wetenschappelijk onderbouwd, ze worden vormgegeven op basis van de intuïtie van leerkrachten en ontwerpers. Dit kan ten koste gaan van hoeveel de leerlingen van de video leren. Dit onderzoek zal bijdragen aan de wetenschappelijke kennis over wanneer instructievideo's succesvol zijn en wanneer niet.

Dit onderzoek gaat over het effect van het luisteren van muziek vóór het kijken van een instructievideo. Het is wetenschappelijk aangetoond dat het luisteren van muziek een verandering in humeur en activiteit veroorzaakt. Het humeur en mate van activiteit draagt bij aan betere leerprestaties.

Uitvoering van het onderzoek

Dit onderzoek zal worden afgenomen in het eigen klaslokaal. Het onderzoek zal één keer worden uitgevoerd, het zal tussen de 45 en 60 minuten duren. Het onderzoek vindt onder schooltijd plaats. Uw kind zal twee soorten vragenlijsten invullen op een laptop van school. De ene vragenlijst bestaat uit vragen over zijn/haar humeur en zijn/haar energieniveau, de andere vragenlijst gaat over de kennis van de inhoud van de instructievideo. De inhoud van

de instructievideo valt onder de lesdoelen van het vak natuurkunde/techniek, passend voor leerlingen tussen de 7 en 12 jaar. Uw kind zal willekeurig worden ingedeeld in één van de vier muziekgroepen: house, jazz, klassiek en rock. De onderzoeksvraag is of de muzieksoort een effect heeft op het leerrendement van de instructievideo. De muziek is zorgvuldig uitgekozen en er is zorg gedragen voor de gepastheid voor de leeftijdscategorie.

Wat wordt van uw kind verwacht

Er wordt van uw kind verwacht dat hij/zij eerlijk is in het invullen van de vragenlijsten. Het is de bedoeling dat hij/zij drie minuten goed luistert naar de muziek, en daarna aandachtig de instructievideo bekijkt. Vervolgens worden er meerkeuzevragen gesteld om het leerrendement te bepalen. Naast de vragenlijsten zullen er geen andere metingen worden uitgevoerd. Er worden geen video-/audio-opnames gemaakt tijdens het onderzoek. Tijdens het onderzoek mag uw kind zelf bepalen wanneer hij/zij pauzeert om bijvoorbeeld naar het toilet te gaan of water te drinken. Er zal ten alle tijden iemand aanwezig zijn om vragen te beantwoorden.

Mogelijke voor- en nadelen van het onderzoek

Uw kind heeft zelf waarschijnlijk voordeel van deelname aan dit onderzoek. De mogelijkheid om deel te nemen aan een wetenschappelijk onderzoek is voor veel kinderen een unieke, waardevolle ervaring. Daarnaast vergroot de deelname de kennis over de ruimtevaart. Bovendien kan het onderzoek belangrijke inzichten opleveren voor de toekomst. De deelname van uw kind kan wel bijdragen aan meer kennis over het ontwerpen van instructievideo's voor optimaal leerrendement.

Nadelen van deelnemen aan het onderzoek kunnen zijn:

- Extra tijd die het uw kind kost
- Het extra geduld dat uw kind moet opbrengen tijdens het luisteren naar het muziekfragment
- Mogelijke confrontatie met het eigen humeur / energieniveau

Vergoeding/beloning

Uw kind krijgt geen vergoeding of beloning voor het deelnemen aan het onderzoek. Het onderzoek kan uw kind extra kennis met betrekking tot het vak natuurkunde/techniek opleveren.

Vertrouwelijkheid verwerking gegevens

Voor dit onderzoek is het nodig dat wij een aantal persoonsgegevens van uw kind en uzelf verzamelen. Het gaat hierbij om zijn/haar naam en de naam van de school. Deze gegevens hebben wij nodig om de onderzoeksvraag goed te kunnen beantwoorden, dan wel om u te kunnen benaderen voor vervolgonderzoek. Daarnaast is dit nodig om, mocht u dat later wensen, de uitkomsten van uw kind te verwijderen. Dit is echter mogelijk totdat het onderzoek geanonimiseerd en gepubliceerd wordt. Na het anonimiseren is het voor niemand meer mogelijk om gegevens aan uw kind te koppelen, ook niet voor de onderzoeker.

Alle informatie die tijdens dit onderzoek wordt verzameld is geheim en zal vertrouwelijk worden behandeld. Alleen de onderzoekers kunnen de uitkomsten zien.

De persoonsgegevens worden zolang dit nodig is op een andere computer opgeslagen dan de onderzoeksgegevens zelf (de zgn. ruwe data). De computer waarop de persoonsgegevens worden opgeslagen is volgens de hoogste normen beveiligd en alleen betrokken onderzoekers hebben toegang tot deze gegevens. De gegevens zelf zijn ook beveiligd door middel van een beveiligingscode.

De ruwe data (onderzoeksgegevens) zullen minimaal 10 jaar bewaard worden. Dit is volgens de daartoe bestemde richtlijnen van de Vereniging van Nederlandse Universiteiten.

Wanneer de gegevens van dit onderzoek zijn geanonimiseerd worden zij opgenomen in een open access database (Faculty of Social and Behavioural Sciences Research Data Storage). Dit betekent dat ook andere onderzoekers deze data kunnen opvragen voor hun eigen onderzoek. In deze data zijn de uitkomsten niet te koppelen aan de persoonsgegevens van uw kind.

Vrijwilligheid deelname

Deelname aan dit onderzoek is vrijwillig. U, of uw kind kan op elk gewenst moment, zonder opgave van reden en zonder nadelige gevolgen, stoppen met het onderzoek. Ook zullen wij letten op signalen die het kind zelf geeft waaruit blijkt dat hij/zij niet meer aan het onderzoek mee wil doen. De tot dan toe verzamelde gegevens worden dan niet gebruikt voor het onderzoek.

Krijg je de resultaten van het onderzoek te horen?

Het onderzoek duurt tot oktober 2022. Je kunt aangeven op het toestemmingsformulier of je een nieuwsbrief over het onderzoek wilt ontvangen.

Als de situatie verandert

Het onderzoek zal zo nauwkeurig mogelijk volgens plan verlopen. Maar als de situatie verandert neemt de onderzoeker contact met u op.

Contactinformatie:

- **Onderzoekers en contactpersoon**
  Als u vragen of opmerkingen over het onderzoek heeft, kunt u contact opnemen met een van de onderzoekers, maar ook met Vincent Hoogerheide. Dit kan door een e-mail te sturen naar V.Hoogerheide@uu.nl

- **Klachtenfunctionaris**
  Als u een officiële klacht heeft over het onderzoek, dan kunt u een mail sturen naar de klachtenfunctionaris via klachtenfunctionaris-fetcsocwet@uu.nl

- **Functionaris Gegevensbescherming:** privacy@uu.nl Zie voor verder informatie over uw privacy rechten de informatie in de bijlage.

Als u na het lezen van deze informatiebrief besluit tot deelname aan het onderzoek vragen wij u bijgevoegd toestemmingsformulier in te vullen, te ondertekenen en in te leveren bij de onderzoeker(s).

Vriendelijke groet,

Sanne Kok

S.P.Kok@students.uu.nl

Bijlagen:

- toestemmingsformulier
- overzicht privacy rechten

Bijlage

Het onderzoek wordt uitgevoerd onder de verantwoordelijkheid van de Universiteit Utrecht (UU). Zij wil duidelijk zijn over de manier waarop zij met uw gegevens omgaat.

De UU leeft de Algemene Verordening Gegevensbescherming en andere privacy wet- en regelgeving na die voor dit onderzoek van toepassing is.

Uw privacy rechten als onderzoeksdeelnemer

In principe heeft u de volgende rechten als onderzoeksdeelnemer:

- u heeft het recht een kopie op te vragen van de persoonsgegevens die gebruikt worden/zijn in het onderzoek
- u heeft het recht uw persoonsgegevens te laten corrigeren wanneer deze niet juist zijn vastgelegd
- u heeft het recht om bezwaar te maken tegen de verwerking van uw persoonsgegevens en recht op gegevensoverdraagbaarheid,
- u heeft het recht op verwijderen van persoonsgegevens (dit kan niet in alle situaties, bijvoorbeeld bij longitudinaal onderzoek als er al publicaties zijn verschenen of als de gegevens bij het onderzoek geanonimiseerd zijn of worden),
- u heeft het recht om toestemming voor het verwerken van de persoonsgegevens in te trekken. Analyses die tot dat moment zijn gemaakt met de betreffende persoonsgegevens zullen wel gebruikt blijven worden voor het onderzoek.

U kunt uw privacy rechten uitoefenen door contact op te nemen met de onderzoekers of via privacy@uu.nl. Van belang is dat u weet dat de Universiteit niet alle verzoeken onder alle omstandigheden hoeft in te willigen of kan inwilligen.

In de Privacyverklaring van de Universiteit vindt u meer informatie over de manier waarop de Universiteit met uw persoonsgegevens omgaat. De privacyverklaring van de Universiteit Utrecht kunt u via onderstaande link vinden:
https://www.uu.nl/organisatie/praktische-zaken/privacy/privacyverklaring

Mocht u van mening zijn dat uw klacht niet tot uw tevredenheid is of worden afgewikkeld, dan heeft u nog het recht om een klacht in te dienen bij de Autoriteit Persoonsgegevens in Den Haag:

https://autoriteitpersoonsgegevens.nl

Informatiebrief voor kinderen

Muziek luisteren voor instructievideo's: de rol van humeur en energieniveau op leerresultaten.

Sanne Kok

In deze brief wil ik je vragen of je deel wilt nemen aan wetenschappelijk onderzoek. Het onderzoek vindt online plaats. Het is goedgekeurd door Universiteit Utrecht. Je mag zelf weten of je mee wilt doen of niet. Je mag tijdens het onderzoek altijd aangeven als je wilt stoppen. In deze brief vertel ik wat je kan verwachten en wat voor soort vragen je kan krijgen. Als je na het lezen van deze brief nog vragen hebt, dan kan je (met hulp van je ouders) een e-mail sturen naar het emailadres onderaan deze brief.

uitvoering van het onderzoek

Je krijgt eerst een vragenlijst met vragen hoe je je voelt. Het is de bedoeling dat je hier eerlijk over bent. Hierna krijg je wat vragen over de video zelf. De video heb je nog niet gezien, maar de vragen zijn om zeker te weten of je nog iets kunt leren van de video. Hierna krijg je drie minuten muziek te horen. Het is de bedoeling dat je goed luistert naar de muziek. Na de muziek krijg je weer vragen over hoe je je voelt. Het is belangrijk dat je eerlijk bent en niet nadenkt over wat je eerder hebt ingevuld. Dan komt de video instructie. Na de video krijg je hier vragen over, dus let goed op!

Achtergrond onderzoek

We gebruiken steeds meer video's tijdens het leren. In de klas maar ook thuis, bijvoorbeeld tijdens het thuisonderwijs. Van sommige video's leer je meer dan van andere. De makers van deze video's staan hier niet altijd bij stil, dus daarom is het belangrijk dat we veel te weten komen hoe het komt dat sommige video's beter zijn. Dit onderzoek gaat over muziek. We willen te weten komen waarom sommige muzieksoorten zorgen dat je meer leert van een video dan de andere muzieksoorten.

Wat wordt van jou verwacht

Als je meedoet aan het experiment, ga je één keer op school de vragenlijsten maken, de muziek luisteren en de video kijken. Je krijgt tijdens dit onderzoek 'extra' videoles over een onderwerp van natuur & techniek. Dit duurt ongeveer 45 minuten / een uur. Het kan zijn dat je de muziek, vragen of de video niet leuk vindt. Misschien vind je het juist heel interessant,

dat verschilt per persoon. Verder zal er niets in het onderzoek gebeuren wat je vervelend kan vinden.

Gemaakte opdrachten

Je naam komt niet te staan op de vragenlijsten die je gaat invullen. Jouw antwoorden krijgen een nummer, zodat alleen de onderzoeker weet welke antwoorden van jou zijn. Dit doen we zodat de antwoorden verwijderd kunnen worden, als je later aangeeft dat je dat wilt. Verder zal niemand jouw antwoorden aan jou kunnen koppelen. Je krijgt ook geen cijfer voor de gemaakte opdrachten. Je mag wel op elk moment aangeven dat je wilt stoppen. Als je stopt, worden al je antwoorden verwijderd. Je mag tussendoor ook pauzes nemen, je mag zelf bepalen wanneer en hoe lang.

Als je dit gelezen hebt en mee wilt doen aan het onderzoek, dan mag je een handtekening (je naam) plaatsen op het toestemmingsformulier.

Voor vragen kun je terecht bij :

Sanne Kok

S.P.Kok@students.uu.nl

Appendix 5: anonymized informed consent checklist

To anonymize the informed consent checklist, participants' names were deleted and the schools' names were adjusted. School x wrote informed consent on paper, school y demanded that the informed consent process took place online to save teachers' workload.

Number	Name	Informed consent	Experimental group
1 school x (5)		X	1
2		X	2
3		X	3
4		X	4
5		X	1
6		X	2

7		X	3
8		X	4
9		X	1
10		x	2
11		X	3
12		X	4
13		x	1
14		X	2
15		X	3
16		X	4
17		X	1
18 school x (5/6)		X	2
19		X	3
20		X	4
21		X	1
22		X	2
23		X	3
24		X	4
25		X	1
26		X	2
27		X	3
28		X	4
29		X	1
30		X	2
31		X	3
32		X	4
33		X	1
34 school x (6)		X	2
35		X	3
36		X	4
37		X	1
38		X	2
39		X	3
40		X	4
41		X	1
42		X	2
43		X	3
44		X	4
45		X	1
46 school y locatie 1 (5)		X	2
47		X	3
48		X	4
49		X	1
50		X	2
51		X	3
52		X	4
53		X	1
54		X	2
55		X	3

56		X	4
57		X	1
58		X	2
59		X	3
60 school y locatie 2 (5)		X	4
61		X	1
62		X	2
63		X	3
64		X	4
65		X	1
66		X	2
67		X	3
68		X	4
69		X	1
70		X	2
71		X	3
72		X	4
73		X	1
74		X	2
75		X	3
76		X	4
77		X	1
78 school y locatie 2 (6)		X	2
79		X	3
80		X	4
81		X	1
82		X	2
83		X	3
84		X	4
85		X	1
86		X	2
87		X	3
88		X	4
89		X	1
90		X	2
91		X	3
92		X	4
93		X	1
94		X	2
95		X	3
96 school y locatie 3 (6)		X	4
97		X	1
98		X	2
99		X	3
100		X	4
101		X	1
102		X	2

103		X	3
104		X	4
105		X	1
106		X	2
107		X	3
108 School y locatie 3 (5)		X	4
109		X	1
110		X	2
111		X	3
112		X	4
113		X	1
114		X	2
115		X	3
116		X	4
117		X	1
118		X	2
120		X	3
121		X	4
122		X	1
123 School y locatie 4 (5)		X	2
124		X	3
125		X	4
126		X	1
127		X	2
128		X	3
129		X	4
130		X	1
131		X	2
132		X	3
133		X	4
134		X	1
135		X	2
136		X	3
137		X	4
138		X	1
139		X	2
140		X	3
141		X	4
142		X	1
143		X	2
144		X	3
145		X	4
146		X	1
147		X	2
148		X	3
149		X	4
150		X	1
151		X	2

152		X	3
153 School y locatie 4 (6)		X	4
154		X	1
155		X	2
156		X	3
157		X	4
158		X	1
159		X	2
160		X	3
161		X	4
162		X	1
163		X	2
164		X	3
165		X	4
166		X	1
167		X	2
168		X	3
169		X	4
170		X	1
171		X	2
172		X	3
173		X	4
174		X	1
175		X	2
176		X	3
177		X	4
178		X	1
179		X	2
180		X	3
181		X	4
182		X	1