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School voor Educatieve Studies

Educatieve master in de
gezondheidswetenschappen

Masterthesis

Embodied learning in adolescents: analyzing well-being and possibilities

Lize Putzeys

Scriptie ingediend tot het behalen van de graad van Educatieve master in de gezondheidswetenschappen

PROMOTOR :

Prof. dr. Wim TOPS

BEGELEIDER :

Mevrouw Lindsay EVERAERT

De transnationale Universiteit Limburg is een uniek samenwerkingsverband van twee universiteiten in twee landen: de Universiteit Hasselt en Maastricht University.



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Abstract

Background: When we look at secondary schools today, being taught while seated is the standard norm. Prolonged sitting is associated with several long-term health problems. Furthermore, sedentary behaviour could affect adolescents' well-being, ranging from mood states to general health-related quality of life. Therefore, introducing physical activity in a classroom is an absolute benefit.

Aim: The current study aimed to explore the impact of several embodied learning possibilities on adolescents' - diagnosed with or without autism spectrum disorder - well-being and concentration/attention.

Participants: Four Belgian secondary schools with different educational forms were included. Following ways of embodied learning were applied: 1) embodied learning standing using extra material, 2) embodied learning standing without using extra material and 3) embodied learning seated with or without using extra material. In total 153 students and 25 teachers participated in the study.

Method: A mixed method (quantitative and qualitative) approach was used: The BPNSFS was used to measure the well-being of both students and teachers. To test attention and concentration, the ATTC questionnaire was used. Further on, a focus group was held to collect more data.

Results: Embodied learning has a significant effect on well-being, no effect on attention and concentration was found.

Conclusion: It was found that teachers are enthusiastic about applying embodied learning in their lessons, as are the students. Still to this day, there is a limited number of research done on this subject, further investigations are recommended.

Key words: embodied learning, embodied cognition, school, BPNSFS, ATTC, focus group discussion, possibilities

Introduction

When looking at secondary schools today, being taught while seated is the standard norm. Prolonged sitting is associated with low back pain (Mahdavi et al., 2021), sitting-induced hemodynamic changes (Tao et al., 2020), obesity and insulin resistance (Sisson et al., 2013). Furthermore, sedentary behaviour could affect adolescents' well-being, ranging from mood states to general health-related quality of life (Penedo & Dahn, 2005). Multiple studies show that students' well-being is an important component for successful learning (Borgonovi & Pal, 2016; OECD, 2018; Putwain, Loderer, Gallard, & Beaumont, 2020). Student's well-being can be dependent on many factors. First, the student-teacher relationship as well as the teacher's interpersonal behaviour are important determinants for a student's well-being. It can make students feel that they are cared for and supported (Zheng, 2022). Secondly, the study of Kuzik et al. (2022) showed that active lessons (an integration of physical activity in the classroom) were favourable in 72% and was positively associated with student's well-being (Kuzik et al., 2022). Lastly, Bird & Markle (2012) reviewed following important factors for student's well-being: personal goal setting, structured mentoring, or life coaching, increasing gratitude, problem solving, and interpersonal skills (Bird & Markle, 2012). Besides student's well-being, attention is also an important aspect within the learning process. Attention can be defined as "Focusing on certain aspects of current experience to the exclusion of others. It is the act of heeding or taking notice or concentrating" (*Attention - MeSH - NCBI*, z.d). Over the last decades, attention has been linked with school performances. Students with attention deficit hyperactivity disorder (ADHD), attention deficit disorder (ADD) and autism spectrum disorder (ASD) are more likely to have poor school performances (Barbaresi et al., 2007; Loe & Feldman, 2007; Mukherjee, 2017). Following consequences on school performance can be experienced by students with ADHD: difficulties in planning and maintaining an overview, being easily distracted and difficulties concentrating (Mentaal Beter, 2022).

A way to break the sedentary pattern in a standard classroom and to promote students' well-being, is by introducing physical activity in the classroom. The meta-analysis by Rodriquez – Allon et al. (2019) shows that being physically more active has a positive effect on adolescents' well-being. Not only does physical activity have a positive effect on well-being but also on students' attention and academic performance (De Greeff et al., 2017). Embodied cognition could be a solution for this problem. Embodied cognition or embodied learning conceptualizes the process of how our body and our environment are related to cognitive processes (Barsalou et al., 1999; Kontra et al., 2015; Shapiro, 2010). In a classroom, embodied learning manifests itself as the combination of movement with a new subject matter being taught. This movement and the teaching of the subject matter happen simultaneously (Hatin, 2020).

There are many possibilities of how embodied learning can be implemented. The paper of Skulmowski & Rey (2018) reviews many embodiment interventions which have been published over the years: whole body movements (e.g., Johnson-Glenberg et al., 2014; Lindgren et al., 2016) or parts of the body, such as gesturing (Goldin-Meadow, 2011; Pouw et al., 2014; Roth., 2001). Different materials can be used for different possibilities of embodied learning, for example: a ball, a step, cones, etc. In 2021 Wienecke et al., published a play-based intervention to investigate how this could affect students' (age range: 7 - 12 years) motivation for mathematics learning (Wienecke et al., 2021).

Embodied learning ensures activation from both the sensory and the motor neurons to acquire relevant information (Barsalou et al., 2003; Niedenthal, 2007). Skriver et al. (2014) showed that increasing children's physical activity levels leads to the release of neurotransmitters that are beneficial to memory formation. Several studies have proposed different hypotheses that could be a possible explanation for the underlying mechanisms of how physical activity affects well-being. First, the endorphins released while performing physical activity might enhance well-being (Dishman & O'Connor, 2009). Endorphins are produced by the pituitary gland and are opioid peptides. These neurotransmitters are responsible for feeling well and happy (Endorfine | Lexicon | Stichting tegen Kanker, z.d.). Secondly, physical activity could increase the brain-derived neurotrophic factor (BDNF) (Cotman et al., 2007) and could provide the growth of new capillaries (Kleim et al., 2002). This neurotrophin is responsible for the neuroplasticity of the brain (Lin & Huang, 2020), which could enhance the structural and functional compositing of the brain, which in turn could increase the welfare (Kleim et al., 2002). A study by Kontra et al. (2015) showed that students being physically active while following class, could earn quiz grades seven percent higher than students who were not physically active. It is worth noting that previous grades matched during the school term (Kontra et al., 2015). In 2021 Wienecke et al. concluded that embodied cognition with usage of a basketball was associated with higher acute levels of experienced autonomy, competence, and intrinsic motivation than classroom-based mathematics (Wienecke et al., 2021). Embodied cognition through integration of movements in the classroom have been proven to be effective to support learning (Mavilidi et al., 2020).

In Belgium there are different educational forms, one of those being special education. These schools allow students with disabilities, such as autism spectrum disorder, to enjoy a customized educational program. Due to a lack of social skills, the classroom environment can be difficult for students with autism to engage in (Memari et al., 2013; Mendelson et al., 2016). Although motor skills are not a diagnostic criterion for the diagnosis of autism, 83% of students with autism have a motor skill deficit (Green et al., 2009; Ruggeri et al., 2019). Due to their limited motor skills, these students are also less physically active than their neurotypical peers (Healy et al., 2017). In 2017, Sadr et al. concluded that by using a therapy ball, students with autism showed less stereotypical behaviour and showed an improvement in their social skills (Sadr et al., 2017).

In summary, no studies were found that compared the different possibilities of embodied learning. Hence, the current study aimed to explore the impact of several embodied learning possibilities on adolescents' - diagnosed with or without autism spectrum disorder - well-being and concentration/attention.

Methods

1. Participants

Current study was conducted in four Belgian secondary schools, independent from each other: Koninklijk Atheneum Maaseik, Atlas college Genk, Van Veldeke Hasselt and SBSO Nautica Merksplas. Secondary schools in Belgium - region Antwerpse Kempen, Vlaams-Brabant, and Limburg - were informed of the study through mail. If interested, an online or physical consultation was scheduled. After the consultation, the four aforementioned schools considered participation. Schools were included if the following criteria were met: a) first and second grade students, b) students diagnosed with or without autism spectrum disorder and c) schools were not allowed to implement embodied learning already. When willing to participate in the study, students/parents and teachers were asked to sign an informed consent. In total 153 students and 25 teachers participated in the study.

The four included schools had three different educational forms. Two schools provide a regular educational form. These official schools are organized and regulated by the Flemish community (Go, z.d.). Within regular education, there are two forms in Belgium: Catholic education and community education, one school of each was added in this study, see table 1. Subsequently, Van Veldeke Hasselt's vision followed the method's educational form, which uses a special pedagogical and didactic approach. The individual development of the student is central to this educational form (van Veldeke, z.d.). Finally, SBSO Nautica Merksplas offers special education to students in two forms of training: OV1 and OV4 (Interlinie Webdesign, www.interlinie.eu, z.d.). Current study included only students from OV4 (students with autism spectrum disorder without mental disabilities that have difficulties with functioning in regular education) (*Scholen voor kinderen met autisme*, z.d.). The wide diversity of the four included schools, see table 1, ensured that the research can be generalized to a broad population.

Table 1: Educational form per school.

School	Educational form
Koninklijk Atheneum Maaseik	Regular education (community education)
Atlas college Genk	Regular education (Catholic education)
Van Veldeke Hasselt	Method education
SBSO Nautica Merksplas	Special education

2. Study design and data collection

Current research consisted of a mixed method (quantitative and qualitative) approach. First, a rapid review was executed to analyse previous literature about knowledge of several embodied learning possibilities. Secondly, well-being and attention questionnaires were administered both before and after the intervention period. Finally, a focus group discussion was held at the end of the intervention. The study was approved by the UHasselt Medical Ethics Committee.

For the quantitative part of the study, the classes of the participants were randomly assigned to the intervention- or control group, depending on the participating teachers. Table 2 shows the number of participants per school, per group as well as the total participants per group. The following data was collected from both the intervention- and the control groups: name, age, academic year, study field, number of embodied learning moments, number of minutes spent on embodied learning, average minutes of embodied learning per lesson moment, which possibility of embodied learning the students received and whether the participants are diagnosed with a developmental disorder. All this listed data was anonymized. Following data was collected for the participating teachers: name, age, years of experience, subject(s) taught, number of embodied learning moments, number of minutes spent on embodied learning, average minutes of embodied learning per lesson moment and the used possibility of embodied learning during classes. This data was also anonymised.

Table 2: Number of participants by group.

	Intervention (n)	Control (n)
Regular community education	26	13
Regular Catholic education	33	31
Method education	22	4
Special education	13	11
Total	94	59

n: number of participants.

2.1. Rapid review

The aim of this rapid review was to gain insights into what opportunities of embodied learning have already been applied in previous research. Prior performing literature search, the following research question was formulated: 'What are the several possibilities of embodied learning?'. PICO statement was defined to select relevant articles related to the research question (Table 3). Articles were excluded if 1) they were not written in English, 2) they were not journal articles, and 3) the discipline was not education. Literature search was performed in several databases including 'Pubmed', 'UHasselt Library' and 'Web of Science' until the 6th of December 2022 (Table 4). The titles, abstracts and full text were screened of each article for eligibility (Figure 1). The quality of the articles was assessed using the CASP checklist (see supplemental 1).

Table 3: PICO statement.

Participants	Students (pre-, primary-, secondary- and high-school)
Intervention	Embodied learning executed in the classroom
Control	No embodied learning executed in the classroom (e.g. passive education)
Outcome	Learning processes, school, education

Table 4: Search strategy in several databases.

Search Terms	("embodied learning" OR "embodied cognition") AND ("class" OR "classroom") AND "school"
Filtered on	Abstract, language = English, journal articles
Results	
Pubmed	4 articles
UHasselt Library	136 articles
Web of Science	22 articles
Date	6/12/2022

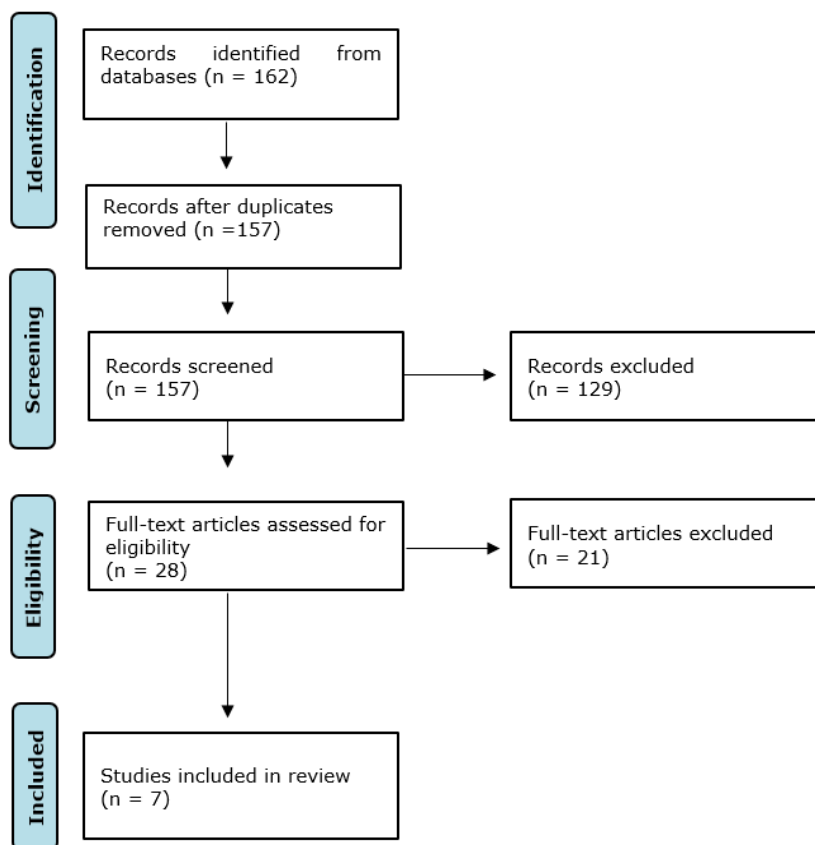


Figure 1: PRISMA flowchart of the search strategy.

2.2 Questionnaires

Students were asked to fill in the BPNSFS and the ATTC questionnaire one week before the intervention period started. The BPNSFS questionnaire consisted of 12 questions regarding student's well-being in the classroom and overall school environment welfare. The ATTC questionnaire consisted of 20 questions regarding students' concentration and attention. To support students in completing the questionnaires, both a teacher and a researcher were present to provide assistance when needed. Completing both questionnaires took about 20 minutes for students.

Teachers were asked to only fill in the BPNSFS questionnaire one week before starting the intervention period. Teachers completed 24 questions about their well-being in the classroom and overall school environment welfare. This took approximately 10 minutes. All questionnaires were completed online using Google Form. Students and teachers scanned a QR-code via smartphone or used computers at school. As a result, the data was immediately received by the researchers and immediately anonymized. One week after the intervention period, students and teachers were asked to fill in the same questionnaires again. Questionnaires were administered both before and after the intervention in the intervention- and control group.

2.2.1 Basic Psychological Need Satisfaction and Frustration Scale (BPNSFS)

BPNSFS was used to measure the well-being of both students and teachers. The advantage of this questionnaire includes the fact that there is a children's version as well as a Dutch version (Van der Kaap et al., 2020). For this study, two different versions of the questionnaire were used. For students the children's version of 12 questions were used, see supplemental 2. As opposed to the teachers, the adult version of 24 questions were used, see supplemental 3. Both versions of the questionnaire assess the three needs for competence, autonomy, and relatedness. This questionnaire was found valid and reliable by Chen et al. (2015) for four different cultural groups. One of these four groups consisted of a Belgium population.

2.2.2 Attention Control Scale (ATTC)

Attention and concentration of the students was tested using the ATTC questionnaire. This is a 20-item questionnaire that is designed to measure two components of attention: attention focusing and attention shifting, see supplemental 4 (Derryberry & Reed, 2002).

In 2007, Muris, Meesters & Rompelberg found an ICC of 0.72 for the child version of the ATTC questionnaire. This demonstrated a satisfactory parent-child agreement. The study validated the child version of the ATTC questionnaire for a population between nine and 13 years of age (Muris et al., 2007).

2.3 Training schedules

Before the start of the study, teachers were handed a training schedule that was drafted by L.E. (lead researcher) and G.V.D.S. (football coach and teacher). These training schedules consisted of practical examples of embodied learning (see supplemental 5). Besides examples of embodied learning, teachers were asked to fill in empty clocks per lesson to indicate the number of minutes embodied learning was performed. Finally, there was a section for each student where the teacher could indicate whether this student was mostly absent and/ or was cooperating well during the embodied learning sessions. Through these training schedules, the following data could be collected: number of embodied learning moments, number of minutes spent on embodied learning and average minutes of embodied learning per lesson moment.

2.4 Focus group discussion

A focus group is used to collect data through a group discussion in which the topic is elected by the lead researcher (Morgan, 1997). In the case of the current study, the topic of the discussion was embodied learning.

The focus group for this study consisted of a diverse group of students and teachers. During an informational session, it was asked which teachers were willing to participate in the focus group discussion. Based on this, students were chosen at random to participate in this discussion. The researchers considered it optimal that one focus group discussion took place to promote the interaction. Due to different teacher's schedules this could not be guaranteed in all the schools, which resulted in multiple focus group discussions in different schools. In Koninklijk Atheneum Maaseik, Atlas College Genk, van Veldeke Hasselt and SBSO Nautica Merksplas respectively two, one, one and three focus group discussions were held.

One week after the intervention period, the focus group discussion took place. This discussion was led by the lead researcher and one or two assistants, who were involved in the study. To increase the validity of the discussion, i.e., to ask the same questions at each school, a question guideline was created (see supplemental 6). Before starting the focus group discussion, participants were asked if they consented the conversation being recorded. Following this consent, an audio recording was started. This audio fragment was later transcribed by the researchers. Finally, the transcript was coded using the NVivo 14 software. This coding was used as data for the study.

3. Intervention

Based on the participating teachers, classes were randomly assigned to a possibility of embodied learning (see table 5). Following the allocation, an information session for all participating teachers and students was held at each school. This session gave an overview of what was expected from teachers and students before, during and after the intervention period.

Table 5: Number of participants per embodied learning possibility.

	EL standing using extra material (n)	EL standing without using extra material (n)	EL seated with or without using extra material (n)
Regular community education	14	6	6
Regular Catholic education	8	12	13
Method education	3	4	15
Special education	5	4	4
Total	30	26	38

EL: embodied learning, n: number of participants.

One week before the intervention period, students and teachers were asked to fill in the questionnaires via Google Form.

The intervention period lasted three weeks. Within these three weeks teachers were asked to implement at least ten minutes of embodied learning during each lesson time. For the method school, one lesson time lasted 100 minutes, but for the other schools one lesson time had a duration of 50 minutes. The researchers distinguished three forms of embodied learning: 1) embodied learning standing using extra material, 2) embodied learning standing without using extra material and 3) embodied learning seated with or without using extra material (see table 6). Classes with participating students were assigned randomly to one of these three intervention groups, depending on the participating teachers. Using their training schedule (see supplemental 5), teachers could get inspiration on how to implement their form of embodied learning in their classrooms.

Table 6: Description of the three embodied learning forms.

Embodied learning	Description
EL St W M	Form of embodied learning in which one stands upright and additional materials are used (e.g., ball, step, cones,...).
EL St Wh M	Form of embodied learning in which one stands upright without usage of additional material, except for material that was standardly provided in a classroom (e.g. table/desk and chair).
EL Sd W/ Wh M	Form of embodied learning in which one is seated. Additional material may (e.g. sitting ball, wobble stool, ball,...) or may not be used for this purpose.

EL: embodied learning, St: standing, W: with, Wh: without, M: extra material

One week after the intervention period, the focus group discussion was held. At the end of the same week students and teachers were asked to fill in the questionnaires for a second time through Google Form. Figure 2 gives an overview on the conduct of the study.



Figure 2: Study overview.

4. Data analysis

Quantitative data were analysed by usage of the software program SPSS version 28.0.1.1 and RStudio version 2021.09.2. The sample characteristics were calculated using descriptive statistics. Categorical variables were presented as n(%). Continuous variables were displayed as mean \pm standard deviation (SD) in normal distribution or median \pm interquartile range (IQR) if not normally distributed.

The well-being, attention and concentration of students before and after the intervention period were assessed in the intervention- and control group for each school separately and all together afterwards. The well-being of all teachers were also assessed before and after the intervention period. The normality of the data was assessed using the Shapiro-Wilk test. The difference between before and after the intervention period within the

intervention group or within the control group was assessed by using a paired t-test in normal distribution or the non-parametric Wilcoxon-signed-rank-test. To assess the difference of data between the intervention group directly with the control group, a two sample unpaired t-test was used for the normally distributed data and the Mann-Whitney-U test was used for not normally distributed data.

To examine the possible influences of gender, age, academic year, study field, embodied learning possibility or average minutes of embodied learning per lesson moment, a multiple regression model was built. Backward stepwise selection was done to remove the least significant variables one at a time. In case the final model was not normally distributed, the rank-based estimation regression was performed (a non-parametric variant of the regression analysis).

The qualitative data from the focus group discussions were processed by usage of the software program NVivo 14. First, the audio recordings were transcribed in Google Docs of Hasselt University. Coding was done by two researchers each time with the software program NVivo by assigning codes to the transcripts. Using a codebook (supplemental 7), the data could be analyzed.

Results

1. Quantitative analysis

1.1 Influence of embodied learning on 'well-being' and 'attention and concentration' of students

1.1.1 Regular community education school

To assess the impact of EL on well-being, attention, and concentration for the intervention- and control group, respectively 26 and 13 students were included (Table 7). The students had a median age of 15 and the majority were in the fourth year of their study. The students in the intervention group had a median of 15 (\pm 10.25) moments of embodied learning with a median of 12.4 (\pm 1.98) minutes of EL per lesson moment (Table 7). There was one student in the intervention group present with autism (Table 7).

Table 7: Characteristics of students in the regular community education school.

	Intervention group (n=26)	Control group (n=13)
Gender (boy)	13 (50%)	7 (53.8%)
Age (years)	15 \pm 1.25	15 \pm 1.0
Year of study		
3 rd year	14 (53.8%)	0
4 th year	12 (46.2%)	13 (100%)
Field of study		
Natural sciences	10 (38.5%)	0
Latin	4 (15.4%)	12 (92.3%)
Modern Languages	1 (3.8%)	0
Human Sciences	5 (19.2%)	0
Economic Sciences	2 (7.7%)	1 (7.7%)
Mathematics	4 (15.4%)	0
Moments of EL	15 \pm 10.25	0
EL per lesson moment (minutes)	12.4 \pm 1.98	0
Developmental disorder		
Autism	1 (3.8%)	0

Continuous data are displayed as mean \pm SD in normal distribution or median \pm IQR if not normally distributed. Categorical data are presented as n(%). EL, embodied learning; SD, standard deviation; IQR, interquartile range.

Well-being was significantly slightly higher in the intervention group after the implementation of EL (score of 3.02/5 compared with 2.85/5, $p=0.006$, Wilcoxon-Signed rank test) (Table 8). No significant difference was found in terms of well-being in the control group before and after the intervention period ($p=1$), neither between the intervention- and control group ($p=0.116$, $p=0.902$) (Table 8). The impact of EL on attention and concentration in the intervention group showed also a small significant difference before (score of 2.26/4) and after (score of 2.28/4) the EL intervention ($p=0.024$) (Table 8). A paired t-test was used to compare before and after the intervention period in the control group indicating no significant difference in attention and concentration ($p=0.547$) (table 8).

Table 8: Comparison of intervention group and control group for well-being, and attention and concentration of students before and after embodied learning in the regular community education school.

Well-being			
Wilcoxon-Signed Rank test	p-value	(CI)	d
Before and after EL – Intervention group	0.006	(-0.250, -0.042)	0.587
Paired t-test	p-value	(CI)	
Before and after EL – Control group	1	(-0.130, 0.130)	
Two Sample Unpaired t-test	p-value	(CI)	
Intervention group and control group – Before EL	0.116	(-0.362, 0.042)	
Two Sample Unpaired t-test	p-value	(CI)	
Intervention group and control group – After EL	0.902	(-0.150, 0.170)	
Attention and Concentration			
Paired t-test	p-value	(CI)	d
Before and after EL – Intervention group	0.024	(-0.218, -0.017)	0.558
Paired t-test	p-value	(CI)	
Before and after EL – Control group	0.547	(-0.097, 0.174)	
Two Sample Unpaired t-test	p-value	(CI)	d
Intervention group and control group – Before EL	0.029	(-0.313, -0.018)	0.783
Two Sample Unpaired t-test	p-value	(CI)	
Intervention group and control group – After EL	0.869	(-0.127, 0.108)	

Statistical significance was observed when $p < 0.05$. Significant p-values are indicated in bold. EL, embodied learning; CI, confidence interval. d, Cohen's d effect size (0.2= small, 0.5= medium, 0.8= large).

Additionally, a multiple regression analysis was performed to predict the dependent variables well-being or, attention and concentration by the effect of the independent variables: 1) gender, 2) age, 3) year of study, 4) field of study, 5) minutes EL per lesson moment, 6) type of EL and, 7) diagnosed with developmental disorders (Table 9). Backward stepwise selection was done to remove the least significant variables one by one. Finally, a final model was constructed (Table 9). Age and type of EL showed a significant positive relationship with the dependent variable well-being ($p=0.023$, $p=0.019$, respectively) (Table 9). The well-being of the students significantly increased as the age increased ($\beta=0.159$, $p=0.023$). When looking at the type of EL, students performing EL standing with extra material showed a significantly increased well-being compared to students performing EL standing without extra material or seated ($\beta=-0.267$, $p=0.019$). The type of EL and the minutes of EL per lesson moment showed no significant relationship with attention and concentration in the final model (Table 9).

Table 9: Multiple regression analysis of intervention group for well-being and, attention and concentration of students in the regular community education school.

Well-being			
Start model			
Dependent variable: well-being after EL in intervention group			
Tested independent variables: gender, age, year of study, field of study, minutes EL per lesson moment, type of EL			
Final Model (as a result of backward selection)			
Dependent variable: well-being after EL in intervention group			
Independent variables: age, type of EL, year of study, field of study			
Variable	R²	β	p-value
Age	0.167	0.159	0.023
Type of EL	0.211	-0.267	0.019
Year of study	0.266	0.349	0.083
Field of study	0.331	0.019	0.090
Attention and Concentration			
Start model			
Dependent variable: attention and concentration after EL in intervention group			
Tested independent variables: gender, age, year of study, field of study, minutes EL per lesson moment, type of EL			
Final model (as a result of backward selection)			
Dependent variable: well-being after EL in intervention group			
Independent variables: type of EL, minutes EL per lesson moment			
Variable	R²	β	p-value
Minutes EL per lesson moment	0.016	0.077	0.114
Type of EL	0.028	0.080	0.269

Statistical significance was observed when $p < 0.05$. Significant p-values are indicated in bold. R² represents the proportion of variance in the dependent variable that could be determined by the independent variables. β represents the estimate of the regression coefficient. EL, embodied learning.

1.1.2 Regular Catholic education school

In the regular Catholic education school, respectively 33 students and 31 students were included in the intervention- and control group (table 10). All students were in their first year of study and had a median age of 12 (± 1.0) years old (table 10). The students in the intervention group had a median of 10 (± 3.5) moments of EL with a median of 28.85 (± 23.19) minutes EL per lesson moment (table 10). Just as regular community education school, there was one student present with autism, but in the control group.

Table 10: Characteristics of students in the regular Catholic education school.

	Intervention group (n=33)	Control group (n=31)
Gender (boy)	25 (75.8%)	19 (61.3%)
Age (years)	12 ± 1.0	12 ± 1.0
Year of study		
1 st year	33 (100%)	31 (100%)
Field of study		
1A stream	25 (75.8%)	31 (100%)
1B stream	8 (24.2%)	0
Moments of EL	10 ± 3.5	0
EL per lesson moment (minutes)	28.85 ± 23.19	0
Developmental disorder		
Autism	0	1 (3.2%)

Continuous data are displayed as mean ± SD in normal distribution or median ± IQR if not normally distributed. Categorical data are presented as n(%). EL, embodied learning; SD, standard deviation; IQR, interquartile range.

Assessing the effect of EL in the regular Catholic education school, EL had no significant effect on well-being or attention and concentration before and after the intervention period in the intervention group ($p=0.597$, $p=0.973$, respectively) (table 11). Furthermore, no significant difference, neither in well-being nor attention and concentration, was found between the intervention and control group (table 11).

Table 11: Comparison of intervention group and control group for well-being and, attention and concentration of students before and after embodied learning in the regular Catholic education school.

Well-being			
Wilcoxon-Signed Rank test	p-value	(CI)	
Before and after EL – Intervention group	0.597	(-0.250, 0.125)	
Paired t-test	p-value	(CI)	
Before and after EL – Control group	0.960	(-0.105, 0.111)	
Two Sample Unpaired t-test	p-value	(CI)	
Intervention group and control group – Before EL	0.375	(-0.219, 0.084)	
Two Sample Unpaired t-test	p-value	(CI)	
Intervention group and control group – After EL	0.797	(-0.193, 0.1490)	
Attention and Concentration			
Paired t-test	p-value	(CI)	
Before and after EL – Intervention group	0.973	(-0.090, 0.093)	
Paired t-test	p-value	(CI) d	
Before and after EL – Control group	0.017	(0.021, 0.201)	0.464
Two Sample Unpaired t-test	p-value	(CI)	
Intervention group and control group – Before EL	0.169	(-0.230, 0.041)	
Two Sample Unpaired t-test	p-value	(CI)	
Intervention group and control group – After EL	0.812	(-0.112, 0.142)	

Statistical significance was observed when $p<0.05$. Significant p-values are indicated in bold. EL, embodied learning; CI, confidence interval. d, Cohen's d effect size (0.2= small, 0.5= medium, 0.8= large).

A multiple regression analysis was also performed for well-being as attention and concentration in the intervention group in the regular Catholic education school (Table 12). Age showed a negative significant relationship with well-being after EL in the intervention group in the final regression model ($p=0.049$). The well-being of students significantly decreased as the age increased ($\beta=-0.183$, $p=0.049$). For attention and concentration, the independent variables age and minutes EL per lesson moment included in the regression model did not show any significant relationship ($p=0.136$, $p=0.169$, respectively) (table 12).

Table 12: Multiple regression analysis of intervention group for well-being and, attention and concentration of students in the regular Catholic education school.

Well-being			
Start model			
Dependent variable: well-being after EL in intervention group			
Tested independent variables: gender, age, field of study, minutes EL per lesson moment, type of EL			
Final Model (as a result of backward selection)			
Dependent variable: well-being after EL in intervention group			
Independent variables: age, minutes EL per lesson moment			
Variable	R²	β	p-value
Age	0.176	-0.183	0.049
Minutes EL per lesson moment	0.190	-0.006	0.193
Attention and Concentration			
Start model			
Dependent variable: attention and concentration after EL in intervention group			
Tested independent variables: gender, age, field of study, minutes EL per lesson moment, type of EL			
Final Model (as a result of backward selection)			
Dependent variable: attention and concentration after EL in intervention group			
Independent variables: Age, minutes EL per lesson moment			
Variable	R²	β	p-value
Age	0.002	-0.106	0.136
Minutes EL per lesson moment	0.037	0.005	0.169

Statistical significance was observed when $p < 0.05$. Significant p-values are indicated in bold. R² represents the proportion of variance in the dependent variable that could be determined by the independent variables. β represents the estimate of the regression coefficient. EL, embodied learning.

1.1.3 Method education school

In the method education school, the number of students included in the intervention group and control group were respectively 22 and four students (Table 13). The majority of students were in their second year of study (table 13). Twenty-four students (92.3%) were following '1A stream of education', while only two students (7.7%) were studying the field of 'Modern Languages' (table 13). Students in the intervention group had only a median of three (± 0.25) moments of EL with a median of 9.25 (± 5.67) minutes performing EL per lesson moment (table 13). Unlike both schools of regular education, no students were diagnosed with a developmental disorder.

Table 13: Characteristics of students in method education school.

	Intervention group (n=22)	Control group (n=4)
Gender (boy)	13 (59.1%)	1 (25%)
Age (years)	13 ± 1.25	13.75 ± 1.5
Year of study		
1 st year	6 (27.3%)	0
2 nd year	14 (63.6%)	2 (50%)
4 th year	2 (9.1%)	2 (50%)
Field of study		
1A stream	20 (90.9%)	4 (100%)
Modern Languages	2 (9.1%)	0
Moments of EL	3 ± 0.25	0
EL per lesson moment (minutes)	9.25 ± 5.67	0
Developmental disorder	0	0

Continuous data are displayed as mean ± SD in normal distribution or median ± IQR if not normally distributed. Categorical data are presented as n(%). EL, embodied learning; SD, standard deviation; IQR, interquartile range.

Evaluating the effect of EL on well-being as well as attention and concentration, no significant differences were found before and/or after the intervention period in the intervention- and control group (table 14).

Table 14: Comparison of intervention group and control group for well-being and, attention and concentration of students before and after embodied learning in method education school.

Well-being		
Wilcoxon-Signed Rank test	p-value	(CI)
Before and after EL – Intervention group	0.879	(-0.167, 0.125)
Paired t-test	p-value	(CI)
Before and after EL – Control group	0.474	(-0.241, 0.408)
Two Sample Unpaired t-test	p-value	(CI)
Intervention group and control group – Before EL	0.771	(-0.378, 0.472)
Wilcoxon rank sum test	p-value	(CI)
Intervention group and control group – After EL	0.471	(-0.083, 0.417)
Attention and Concentration		
Paired t-test	p-value	(CI)
Before and after EL – Intervention group	0.469	(-0.062, 0.130)
Paired t-test	p-value	(CI)
Before and after EL – Control group	0.520	(-0.605, 0.380)
Two Sample Unpaired t-test	p-value	(CI)
Intervention group and control group – Before EL	0.310	(-0.184, 0.459)
Two Sample Unpaired t-test	p-value	(CI)
Intervention group and control group – After EL	0.939	(-0.273, 0.255)

Statistical significance was observed when $p < 0.05$. Significant p-values are indicated in bold. EL, embodied learning; CI, confidence interval.

By performing a multiple regression analysis on well-being after EL, a positive significant relationship was demonstrated with minutes of EL per lesson moment which was included in the final model ($p=0.028$) (table 15). The well-being of the students significantly increased as the students had longer EL moments during lessons ($\beta=0.015$, $p=0.028$). On the other hand, the regression analysis on attention and concentration showed no significant relationship with the independent variable gender in the final model ($p=0.325$) (Table 15).

Table 15: Multiple regression analysis of intervention group for well-being and, attention and concentration of students in method education school.

Well-being			
Start model			
Dependent variable: well-being after EL in intervention group			
Tested independent variables: gender, age, year of study, field of study, minutes EL per lesson moment, type of EL			
Final Model (as a result of backward selection)			
Dependent variable: well-being after EL in intervention group			
Independent variables: Minutes EL per lesson moment			
Variable	R²	β	p-value
Minutes EL per lesson moment	0.129	0.015	0.028*
Attention and Concentration			
Start model			
Dependent variable: attention and concentration after EL in intervention group			
Tested independent variables: gender, age, year of study, field of study, minutes EL per lesson moment, type of EL			
Final Model (as a result of backward selection)			
Dependent variable: attention and concentration after EL in intervention group			
Independent variables: Gender			
Variable	R²	β	p-value
Gender	0.001	0.152	0.325

Statistical significance was observed when $p < 0.05$. Significant p-values are indicated in bold. R² represents the proportion of variance in the dependent variable that could be determined by the independent variables. β represents the estimate of the regression coefficient.

EL, embodied learning.

*Non-parametric rank-based estimation regression was utilised since the data of the final model was not normally distributed.

1.1.4 Special education school

In the special education school, the intervention- and control group included 13 and 11 students respectively (table 16). The special education students had a median age of 13 years old, and the majority (54.2%) were in their first year of study. The students in the intervention group had a median of nine (± 11.0) moments performing EL with a median of 22.5 (± 14.1) minutes EL per lesson moment (table 16). There were 10 students (76.9%) with autism and three students (23.1%) with a combination of developmental disorders in the intervention group. All students in the control group were diagnosed with autism spectrum disorder (table 16).

Table 16: Characteristics of students in special education school.

	Intervention group (n=13)	Control group (n=11)
Gender (boy)	12 (92.3%)	9 (81.8%)
Age (years)	13 ± 3.0	13.45 ± 0.93
Year of study		
1 st year	8 (61.5%)	5 (45.5%)
2 nd year	1 (7.7%)	6 (54.5%)
4 th year	4 (30.8%)	0
Field of study		
1A stream	4 (30.8%)	0
1B stream	5 (38.5%)	11 (100%)
Organisation and Logistics	4 (30.8%)	0
Moments of EL	9 ± 11.0	0
EL per lesson moment (minutes)	22.5 ± 14.1	0
Developmental disorder		
Autism	10 (76.9%)	11 (100%)
Combination	3 (23.1%)	0

Continuous data are displayed as mean ± SD in normal distribution or median ± IQR if not normally distributed. Categorical data are presented as n(%). EL, embodied learning; SD, standard deviation; IQR, interquartile range.

Like the method education school, participants in special education school did not show any significant differences between intervention and/or control group before and after the intervention period for well-being as well as attention and concentration (table 17).

Table 17: Comparison of intervention group and control group for well-being and, attention and concentration of students before and after embodied learning in special education school.

Well-being		
Paired t-test	p-value	(CI)
Before and after EL – Intervention group	0.860	(-0.168, 0.142)
Paired t-test	p-value	(CI)
Before and after EL – Control group	1	(-0.263, 0.263)
Two Sample Unpaired t-test	p-value	(CI)
Intervention group and control group – Before EL	0.149	(-0.100, 0.611)
Two Sample Unpaired t-test	p-value	(CI)
Intervention group and control group – After EL	0.091	(-0.048, 0.584)
Attention and Concentration		
Paired t-test	p-value	(CI)
Before and after EL – Intervention group	0.931	(-0.198, 0.182)
Paired t-test	p-value	(CI)
Before and after EL – Control group	0.244	(-0.344, 0.098)
Two Sample Unpaired t-test	p-value	(CI)
Intervention group and control group – Before EL	0.654	(-0.198, 0.309)
Two Sample Unpaired t-test	p-value	(CI)
Intervention group and control group – After EL	0.500	(-0.241, 0.122)

Statistical significance was observed when $p < 0.05$. Significant p-values are indicated in bold. EL, embodied learning; CI, confidence interval.

For the special education school, the multiple regression analysis showed no significant relationship with the independent variables gender and field of study for well-being in the final model ($p=0.287$, $p=0.109$, respectively) (table 18). For attention and concentration, the independent variable gender, included in the final regression model, did also not show a significant relationship ($p=0.112$) (table 18).

Table 18: Multiple regression analysis of intervention group for well-being and attention and concentration of students in special education school.

Well-being			
Start model			
Dependent variable: well-being after EL in intervention group			
Tested independent variables: gender, age, year of study, field of study, minutes EL per lesson moment, type of EL, developmental disorder			
Final Model (as a result of backward selection)			
Dependent variable: well-being after EL in intervention group			
Independent variables: field of study, gender			
Variable	R²	β	p-value
Field of study	0.080	-0.191	0.109
Gender	0.101	0.359	0.287
Attention and Concentration			
Start model			
Dependent variable: attention and concentration after EL in intervention group			
Tested independent variables: gender, age, year of study, field of study, minutes EL per lesson moment, type of EL, developmental disorder			
Final Model (as a result of backward selection)			
Dependent variable: attention and concentration after EL in intervention group			
Independent variables: gender			
Variable	R²	β	p-value
Gender	0.142	0.296	0.112

Statistical significance was observed when $p < 0.05$. Significant p-values are indicated in bold. R² represents the proportion of variance in the dependent variable that could be determined by the independent variables. β represents the estimate of the regression coefficient. EL, embodied learning.

1.1.5 Complete analysis of the four schools

Furthermore, an entire analysis for all students included in the study was performed to have an overall view on the impact of EL on both well-being as well as attention and concentration. Overall, the intervention group contained 93 students and the control group 59 students in total (table 19). The overall median age was 13 (± 3.0) years old. The majority of included students (53.9%) were in their first year of study. Students in the intervention group had a median of 10 (± 9.25) moments with a median of 18.9 (± 18.15) minutes of EL each lesson moment (table 19). A total of 11 (11.7%) students with autism and three (3.2%) students with a combination of developmental disorders were present in the intervention group. On the other hand, 12 (20.3%) students had autism in the control group (table 19).

Table 19: Characteristics of total students included in the study.

	Intervention group (n=93)	Control group (n=59)
Gender (boy)	62 (67%)	36 (61%)
Age (years)	13 ± 3.0	13 ± 3.0
Year of study		
1 st year	46 (50%)	36 (61%)
2 nd year	15 (16%)	8 (13.6%)
3 rd year	14 (14.9%)	0
4 th year	18 (19.1%)	15 (25.4%)
Field of study		
Natural Sciences	10 (10.6%)	0
Latin	4 (4.3%)	12 (20.3%)
Modern Languages	3 (3.2%)	0
Economic Sciences	2 (2.1%)	1 (1.7%)
1A stream	49 (52.1%)	35 (59.3%)
1B stream	12 (13.8%)	11 (18.6%)
Mathematics	4 (4.3%)	0
Organization and Logistics	4 (4.3%)	0
Moments of EL	10 ± 9.25	0
EL per lesson moment (minutes)	18.9 ± 18.15	0
Developmental disorder		
Autism	11(11.7%)	12 (20.3%)
Combination	3 (3.2%)	0

Continuous data are displayed as mean ± SD in normal distribution or median ± IQR if not normally distributed. Categorical data are presented as n(%). EL, embodied learning; SD, standard deviation; IQR, interquartile range.

Well-being significantly slightly increased in the intervention group after receiving EL (score of 2.94/5 compared with 2.78/5, $p=0.020$, Wilcoxon-Signed rank test) (Table 20). Utilizing the latter statistical test, no significant difference was shown for attention and concentration in the intervention group before and after EL ($p=0.760$) (table 20). The control group displayed a small significant difference before and after the intervention period for attention and concentration using the same non-parametric test ($p=0.037$), while this was not the case for well-being of the students in the same group ($p=0.567$) (table 20). There was no significant difference present between intervention and control group before EL and after EL neither for well-being nor attention and concentration (table 20).

Table 20: Comparison of intervention group and control group for well-being, attention and concentration of students before and after embodied learning in all schools.

Well-being			
Wilcoxon-Signed rank test	p-value	(CI)	d
Before and after EL – Intervention group	0.020	(-0.208, <-0.001)	0.312
Wilcoxon-Signed rank test	p-value	(CI)	
Before and after EL – Control group	0.567	(-0.208, 0.083)	
Wilcoxon rank sum test	p-value	(CI)	
Intervention group and control group – Before EL	0.860	(-0.167, 0.083)	
Wilcoxon rank sum test	p-value	(CI)	
Intervention group and control group – After EL	0.310	(-0.083, 0.167)	
Attention and Concentration			
Wilcoxon-Signed rank test	p-value	(CI)	
Before and after EL – Intervention group	0.760	(-0.075, 0.050)	
Wilcoxon-Signed rank test	p-value	(CI)	d
Before and after EL – Control group	0.037	(<0.001, 0.175)	0.190
Wilcoxon rank sum test	p-value	(CI)	
Intervention group and control group – Before EL	0.063	(-0.200, <0.001)	
Two Sample Unpaired t-test	p-value	(CI)	
Intervention group and control group – After EL	0.749	(-0.090, 0.065)	

Statistical significance was observed when $p < 0.05$. Significant p-values are indicated in bold. EL, embodied learning; CI, confidence interval. d, Cohen's d effect size (0.2= small, 0.5= medium, 0.8= large).

A multiple regression analysis was also performed for well-being as well as attention and concentration of included students in all schools. Analysing well-being, the independent variable 'minutes of EL per lesson moment' did not demonstrate a significant relationship included in the final model ($p=0.100$) (table 21). Since the data of the final model were not normally distributed, non-parametric rank-based estimation regression was utilized. No significant results were obtained. The multiple regression analysis on the dependent variable 'attention and concentration' also showed no significant relationship with minutes EL per lesson moment in the final model ($p=0.204$) (table 21).

Table 21: Multiple regression analysis of intervention groups for well-being, attention and concentration of students in all schools.

Well-being			
Start model			
Dependent variable: well-being after EL in intervention group			
Tested independent variables: gender, age, year of study, field of study, minutes EL per lesson moment, type of EL, developmental disorder			
Final Model (as a result of backward selection non-parametric rank-based estimation regression)			
Dependent variable: well-being after EL in intervention group			
Independent variables: Minutes EL per lesson moment			
Variable	R²	β	p-value
Minutes EL per lesson moment	0.069	-0.0073	0.100*
Attention and Concentration			
Start model			
Dependent variable: attention and concentration after EL in intervention group			
Tested independent variables: gender, age, year of study, field of study, minutes EL per lesson moment, type of EL, developmental disorder			
Final Model (as a result of backward selection)			
Dependent variable: attention and concentration after EL in intervention group			
Independent variables: Minutes EL per lesson moment			
Variable	R²	β	p-value
Minutes EL per lesson moment	0.006	0.0026	0.204

Statistical significance was observed when $p < 0.05$. Significant p-values are indicated in bold. R² represents the proportion of variance in the dependent variable that could be determined by the independent variables. β represents the estimate of the regression coefficient.

EL, embodied learning.

*Non-parametric rank-based estimation regression was utilized since the data of the final model was not normally distributed.

1.2 Influence of embodied learning on 'well-being' of teachers

Moreover, the impact of EL on the well-being of teachers was also assessed. A total of 25 teachers were included in the intervention group of which only four (16%) were male (table 22). The teachers had a mean age of 39.5 (\pm 9.5) years old. All teachers taught a median of four (\pm 4.5) moments of EL with a mean of 14.1 (\pm 4.3) minutes each lesson moment (table 22).

Table 22: Characteristics of all teachers.

	Intervention group (n=25)
Gender (boy)	4 (16%)
Age (years)	39.5 ± 9.5
Subject	
Behavioral and Social Sciences	1 (4%)
Ethics	1 (4%)
English	1 (4%)
Chemistry	1 (4%)
Latin	1 (4%)
Religion	1 (4%)
Engineering Natural Sciences	1 (4%)
Applied Economics	1 (4%)
Mathematics	3 (12%)
Natural Sciences	3 (12%)
Dutch	4 (16%)
Dutch & social education	1 (4%)
History	1 (4%)
French	2 (8%)
Nature and Space	1 (4%)
History and English	2 (8%)
Moments of EL	4 ± 4.5
EL per lesson moment (minutes)	14.1 ± 4.3

Continuous data are displayed as mean ± SD in normal distribution or median ± IQR if not normally distributed. Categorical data are presented as n(%). EL, embodied learning; SD, standard deviation; IQR, interquartile range.

To compare the state of well-being of all teachers before and after EL, a Wilcoxon-Signed rank test was performed. No significant difference was obtained (Table 23).

Table 23: Comparison of well-being of all teachers in the intervention group before and after embodied learning.

Well-being		
Wilcoxon-Signed rank test	p-value	(CI)
Before and after EL – Intervention group	0.702	(-0.118, 0.083)

Statistical significance was observed when $p < 0.05$. Significant p-values are indicated in bold. EL, embodied learning; CI, confidence interval.

Lastly, a multiple regression analysis was performed as well for all teachers to observe the relationship between the predictors and the dependent variable 'well-being' (table 24). The independent variable 'subject' in the final regression model did not demonstrate a significant relationship with well-being of the teachers ($p=0.074$).

Table 24: Multiple regression analysis for well-being of all teachers of the intervention group.

Well-being			
Start model			
Dependent variable: well-being after EL in intervention group			
Tested independent variables: gender, age, subject, minutes EL per lesson moment, type of EL			
Final Model (as a result of backward selection)			
Dependent variable: well-being after EL in intervention group			
Independent variables: Subject			
Variable	R²	β	p-value
Subject	0.132	-0.0127	0.074

Statistical significance was observed when $p < 0.05$. Significant p-values are indicated in bold. R² represents the proportion of variance in the dependent variable that could be determined by the independent variables. β represents the estimate of the regression coefficient. EL, embodied learning.

2. Qualitative analysis.

Based on the focus group discussions, following results were found. Even though the schools have different school visions (regular, method or special education) they all actually concluded the same thing, with an occasional outlier. Therefore, the researchers decided to make an entire analysis of the four schools together.

It was clear from all focus groups that no one had really heard of the concept of embodied learning, as current researchers described it. People had already heard and also worked with the so-called "active breaks" which can be defined as a movement given between subject matter, which mainly serves to refresh attention.

Quote teacher: "Not being so aware of the concept of active breaks and embodied learning, I did often walk through class which is then seen as "active breaks" and not embodied learning. It really is something different now I notice."

Quote Teacher: "When I initially received the mail to participate, I thought, oh okay we do that regularly anyway, I already let them exercise regularly. But then it became clear that it really was something different. That there really is a difference between active breaks and embodied learning as embodied learning itself."

Thus, the prior knowledge of the concept of embodied learning could pretty much be considered non-existent. When asked how embodied learning was perceived, students answered that they all found it enjoyable to participate in. Students preferred embodied learning with an object, the ball was very common, as well as the sitting ball.

Quote Student : "Just replace a chair with a skippy ball. That seems like fun that you follow the lesson along on a skippy ball and not necessarily ten minutes of embodied learning, but just the whole lesson hour."

The teachers themselves indicated that it depends on the type of subject matter / course whether it could be linked well with embodied learning.

Quote Teacher: "Yes that is not always easy. Some parts lend themselves very well to embodied learning, others absolutely not. It's unions. It's curriculum-specific. And it's also group-specific. Ultimately a certain subject matter is going to be much easier for other groups, while for others it's just not going to be that way."

Teachers preferred to teach new material without embodied learning, but when practicing or repeating the subject matter, teachers preferred to use embodied learning. It would be possible to teach new material when students sit on a beanbag or sitting ball. The teachers also indicated that embodied learning took a bit more preparation, because they had to see how they could link the lesson material to the use of embodied learning. Teachers also made it clear that this is a matter of habit. When they get used to the concept of embodied learning, the preparation is easier. The teachers also said that they saw that the students are more enthusiastic in class, that there is a greater group feeling between students and that they encourage each other, etc.

Quote Teacher: "I did always notice afterwards that you, the students, had much more energy to continue working, writing assignments or whatever. Much calmer work. Much more focus in class, and this by moving for a moment."

When asked whether it would be achievable to conduct embodied learning in the future, the answer was a unanimous yes. Although, minor adjustments could be made. It clearly shows that people want variation, variation in type of embodied learning as well as not continuously having to apply embodied learning in every lesson. Courses for which several hours are planned are easier to participate in embodied learning than for example a one-hour course. Each school indicates that a large room, such as a study hall, would provide more space to implement embodied learning. Embodied learning outside is also a possibility. Furthermore, they also indicate that when it would be more established, already from elementary school, embodied learning would run more easily. Not to be confused with getting used to, variety and variation should always be guaranteed.

The students indicated that they were not able to concentrate better on subject matters. Furthermore, embodied learning had no influence on their learning process, but they were enthusiastic and enjoyed participating in embodied learning, were closer as a class which was therefore motivating. Something the teachers also noted.

In special education, there was a clear indication by the students that embodied learning was too busy, it gave too many stimuli, which made it harder to concentrate. Because of the sound of e.g. a ball, students had eyes only for the ball and not for something else. Students got the feeling of learning less. However, there was also a positive, enthusiastic feeling here. Teachers indicated that 'time' is a major limitation here. Students specifically here with ASD have difficulty adapting. If embodied learning would become a 'known fact' at school, this aspect could become easier.

Furthermore, the students also indicated that they saw embodied learning as achievable in the future and would like to continue doing so. They were all very enthusiastic at the start of the study, at all schools and still were at the end. But also, they wanted variety, not always the same type of embodied learning. Students would like to use the sitting ball, try the bike desk or walking desk in the future. Similar to the teachers, students would find it more enjoyable in a larger space or outside.

Student: "I really enjoyed doing embodied learning. I really liked the fact that you don't have to sit still all the time. I do think there should be enough variety. Not the same type of movement every time."

Discussion and conclusion

The aim of current study was to explore the impact of several embodied learning possibilities on adolescents' well-being and attention/concentration. This research question was examined via a quantitative analysis (questionnaires and intervention period) and qualitative analysis (focus group discussion).

Reflection on the research questions and its results

When looking at the general results, a small significant difference was found for student's well-being in the intervention group. Since there was no significant difference in concentration and attention, we may conclude that embodied learning has no positive or negative effects on student's ability to pay attention in class while performing embodied movements. This is in contrast with the findings of Tomporowski en Qazi (2020). Following theories concluded that dual-task conditions, which require motor movement, negatively affect the ability to store semantic information into the long-term memory. The planning and correction of the motor tasks would compete with the ability with strategies needed for memory storage (Tomporowski & Qazi, 2020). These findings are in contrast with the study of Schmidt et al. (2019). They concluded that embodied learning was more effective in learning primary school children new vocabulary than a control condition ($d=1.12$). In addition, this study showed that EL had no negative or positive effect on the attention of these children (Schmidt et al., 2019). The findings of Schmidt et al. (2019) are in line with the findings of the current study. The contradictions of the articles above, shows that there is still a lack of understanding regarding the effect of embodied learning on attention. Further research on this topic is required.

Given that the BPNSFS questionnaire (post intervention) was administered one week before an exam period, researchers expect that embodied learning could have an even greater effect on well-being when performed in a less stressful period. Besides having a stressful exam period, a student's well-being can also depend on the family environment (Fauzi et al., 2022). The study of Fauzi et al. (2022) concluded that adolescents had a better subjective well-being when they received better parenting practices.

The focus group discussion was used to ascertain students' and teachers' experiences of different embodied learning possibilities. Unlike an interview, a focus group uses the interaction of the group to collect data. This research method expects an active role from the researcher for collecting data (Morgan, 1997). Some of these focus groups went very smoothly, others rather reluctant. This could be due to the fact that the four included schools had different school visions. For example, the school that used the method educational form taught their students to engage in conversations (*van Veldeke, z.d.*). Whereas in other schools, this was not their main vision. It was noticeable that method education students participated more fluently in these focus group discussions.

Embodied learning was unknown at the start of the study. Both students and teachers were unsure what to expect from this concept. Teachers were unsure how they should go about implementing embodied learning in their lesson time. Researchers wonder, if embodied learning were more integrated in, for instance, teacher education or in the curriculum itself, whether embodied learning would be more familiar and easier to implement in lessons and if more time would be spent on embodied learning during the lesson itself.

Interestingly, in special education we found no influence of embodied learning, neither on well-being, nor on concentration. Qualitative research showed that students with ASD perceived embodied learning as a more distracting stimulus and thus reported to be less concentrated. This is in line with the article by Kanakri et al. (2017). Teachers indicated that for students with ASD, embodied learning could be more convenient if they were more familiar with it and this was included in the daily structure or daily planning. Kanakri et al. (2017) demonstrated that students with ASD need more structure during daily activities.

The qualitative research showed that teachers experienced that certain subject matters are more suited to embodied learning than others. For example, they felt that embodied learning could be more easily applied to history, but not mathematics. Teachers indicated that the process of processing the content of a subject such as history is done in a different way from mathematics. This contradicts previous research which studied the effect of embodied cognition only in mathematics and obtained positive results (Weisberg & Newcombe, 2017; Abrahamson & Bakker, 2016; Tran et al., 2017).

Thereafter, the lesson content would determine which option of embodied learning is more easily applicable. Teachers like to have a choice when it comes to the embodied learning possibilities, they would start from their lesson content and choose the most applicable possibility for each component in their lesson. The study recommends implementing a combination of embodied learning possibilities in one lesson.

Additionally, students indicate that different possibilities of embodied learning provide variety, which is expected to be more motivating. This is consistent with Deci & Ryan's self-determination theory (2000), which states that the pursuit of autonomous motivation in students is important to positively influence learning outcomes. This autonomous motivation can be increased by offering more variety in lessons (Struyven et al., 2022). Although variety would bring more motivation to students, Everaert et al. (2023) showed that using only a senseball for embodied learning already had a positive effect on the well-being of fourth grade secondary school students.

Furthermore, teachers reported that students are more enthusiastic during class and a greater sense of belonging was shown while performing embodied learning.

Lastly, from the seven focus groups, a ball was indicated as the favourite object to engage in embodied learning.

Based on the statistical analysis, we can conclude that embodied learning has a significant, small effect on the well-being of students after the intervention period. This corresponds with our qualitative analysis where students experienced positive, enthusiastic feelings as well as with previous research finding improvement of overall social behaviour, in-seat behaviour, and attending with a specific type of embodied learning (Sadr et al., 2017; Schilling et al., 2004; Krombach et al., 2020; Schilling et al. 2003).

Strengths and limitations

Like others, the current study has its strengths and limitations. The first strength was that both the BPNSFS and the ATTC were validated questionnaires (Chen et al., 2005; Murriss et al., 2007). Secondly, the simple method makes this study easy to reproduce. The study results are generalizable to the entire population due to three reasons: 1) a well-mixed sample size (67% boys and 33% girls), 2) four types of secondary schools were included in the study and 3) autism and other developmental disabilities were taken into account. Subsequently, both teachers and students were surveyed. These results were deemed equivalent by the researchers. To strengthen the results, qualitative research was used in addition to the quantitative research. Fourthly, teachers were supervised by the

researchers in the first week of the intervention period to provide tips and feedback in order to enhance their lessons. Additionally, a training schedule was provided as an extra aid to prepare the lesson preparations.

In addition to these strengths, the study also had some limitations. It is always possible for participants to give socially desirable answers, this can lead to response bias. Another possible bias for this study is the recall bias. The questionnaires were designed to ask about information from the past week. It is possible that participants could not correctly assess their welfare status over the past week, or they just did not remember it. In addition to these biases, another weakness was implemented in the intervention. One week after the intervention period, students and teachers were asked to fill in the same questionnaires again. This time there was no researcher present. The absence of the researcher led to questionnaires not being completed or being completed late. Although the researchers had explicitly asked the participating schools if they needed to be present for the post questionnaires, they all said no with above mentioned implications. In the special needs school, there was high dropout as students switched schools or were accommodated at home. The researchers had no influence on this dropout, but this made fewer students from this group participate.

The three-week intervention period was interrupted by a one-week holiday period. During which, there was no embodied learning. Three full consecutive weeks might have given different results.

Future recommendations

Still to this day, there is a limited number of research done on this subject, further investigations are recommended. A first recommendation done by the researchers is to explore a long-term effect. Within this study an intervention period of only three weeks was implemented, which is rather a short-term period. For future research, it is recommended to use an intervention period of, for example, six months. A second recommendation would be one of a mixed embodied learning intervention. Within this intervention teachers could choose between the different possibilities of embodied learning, which could make embodied learning easier adaptable to their lesson subjects. Subsequently, this could have a positive effect on teachers' well-being. A third recommendation would be to investigate the effect embodied learning could have on a student's attention. As mentioned earlier, there are conflicting findings on this effect. A proper study might well find an appropriate answer to this ambiguity.

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Supplementals

Supplemental 1: Quality assessment of included articles using CASP checklist.

	Vesna Geršak, Tina Giber, Gregor Geršak, Jerneja Pavlin	Linn Damsgaard, Anne-Mette Veber Nielsen, Anne Kær Gejl, Anne Sofie Bøgh Malling, Søren Kildahl Jensen, Jacob Wienecke	Liu, SM and Takeuchi, MA	Neila Chettaoui, Ayman Atia, Med. Salim Bouhler	McClelland, Elizabeth; Pitt, Anna; Stein, John	Nimota jibola Kadir Abdulahi	Rankin, Joss; Garrett, Robyn; MacGill, Belinda
1. Was there a clear statement of the research aim?	Yes	Yes	Yes	Yes	Yes	Yes	Can't tell
2. Is a qualitative methodology appropriate?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3. Was the research design appropriate to address the aims?	Can't tell	Yes	Yes	Yes	Yes	Yes	Yes
4. Was the recruitment strategy appropriate to address the aims?	No	Yes	No	Yes	Yes	Yes	Yes
5. Was the data collected in a way that addressed the research issue?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
6. Has the relationship between researcher and participants been adequately considered?	Yes	Yes	Yes	Yes	Yes	Yes	Yes

7. Have ethical issues been taken into consideration?	Yes	Yes	Yes	Yes	Can't tell	Yes	Yes
8. Was the data analysis sufficiently rigorous?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
9. Is there a clear statement of findings?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
10. How valuable is the research?	Extensive study, generalizable to high school students	Young population	Seven racialized multilingual learners, small population	Young population	Extensive study	Extensive study	Small population

Supplemental 2: Student's version of the BPNSFS. The questionnaire was provided in the native language (Dutch).

Hieronder willen we meten welke specifieke gevoelens je DEZE WEEK OP SCHOOL hebt ervaren. Je

kan een score toekennen van 1 ('helemaal niet akkoord') tot 5 ('helemaal akkoord') om aan te in welke mate een bepaald gevoel op dit moment van je leven van toepassing is.

Gelieve de stellingen te beoordelen aan de hand van de volgende schaal:

De voorbije week...

1. ... had ik in de klas een gevoel van keuze en vrijheid in de dingen die ik ondernam.
2. ... voelden de meeste dingen die ik deed op school aan alsof 'het moest'.
3. ... voelde ik me uitgesloten uit de groep medeleerlingen waar ik bij wil horen.
4. ... had ik er vertrouwen in dat ik dingen op school goed kan doen.
5. ... voelde ik dat mijn beslissingen weerspiegelen wat ik echt wil.
6. ... voelde ik me in de klas gedwongen om dingen te doen waar ik zelf niet voor zou kiezen.
7. ... voelde ik me verbonden met mijn vrienden op school.
8. ... voelde ik dat mijn leerkrachten en medeleerlingen koud en afstandelijk waren tegen mij.
9. ... voelde ik me teleurgesteld in mijn schoolse prestaties.
10. ... had ik een warm gevoel bij de leerlingen en leerkrachten waarmee ik tijd doorbracht.
11. ... voelde ik me onzeker over mijn vaardigheden.
12. ... voelde ik me bekwaam in wat ik deed op school.

Supplemental 3: Teacher's version of the BPNSFS. The questionnaire was provided in the native language (Dutch).

Hieronder peilen we naar je ervaringen op school tijdens de afgelopen 3 maanden.

Gelieve elk van

de stellingen hieronder goed te lezen en aan te geven of deze waar zijn voor jou door een getal tussen 1 (helemaal niet waar) en 5 (helemaal waar) aan te duiden.

Op school...

1. ... ervaar ik een gevoel van keuze en vrijheid in de dingen die ik onderneem.
2. ... voelen de meeste dingen die ik doe aan alsof het moet.
3. ... voel ik dat de mensen waar ik om geef, ook geven om mij.
4. ... voel ik me uitgesloten uit de groep waar ik bij wil horen.
5. ... heb ik er vertrouwen in dat ik dingen goed kan doen.
6. ... heb ik ernstige twijfels over de vraag of ik de dingen wel goed kan doen.
7. ... voel ik dat mijn beslissingen weerspiegelen wat ik echt wil.
8. ... voel ik me gedwongen om veel dingen te doen waar ik zelf niet voor zou kiezen.
9. ... voel ik me verbonden met mensen die om mij geven en waar ik ook om geef.
10. ... voel ik dat mensen die belangrijk voor me zijn koud en afstandelijk zijn tegen mij.
11. ... voel ik me bekwaam in wat ik doe.
12. ... voel ik me teleurgesteld in veel van mijn prestaties.
13. ... voel ik dat mijn keuzes weergeven wie ik werkelijk ben.
14. ... voel ik me verplicht om te veel dingen te doen.
15. ... voel ik me nauw verbonden met andere mensen die belangrijk voor me zijn.
16. ... heb ik de indruk dat mensen waarmee ik tijd doorbreng een hekel aan me hebben.
17. ... voel ik me in staat om mijn doelen te bereiken.
18. ... voel ik me onzeker over mijn vaardigheden.
19. ... voel ik dat wat ik tot nu toe gedaan heb me oprecht interesseert.
20. ... voelen mijn dagelijkse activiteiten aan als een aaneenschakeling van verplichtingen.
21. ... heb ik een warm gevoel bij mensen waarmee ik tijd doorbreng.
22. ... voel ik dat de relaties die ik heb slechts oppervlakkig zijn.
23. ... voel ik dat ik moeilijke taken met succes kan voltooien.
24. ... voel ik me als een mislukking omwille van de fouten die ik maak.

Supplemental 4: ATTC questionnaire. The questionnaire was provided in the native language (Dutch).

Here are some different ways that people can feel about working and concentrating. Please indicate how strongly each statement applies to you.

1 = Almost never, 2 = Sometimes, 3 = Often ,4 = Always

1. It's very hard for me to concentrate on a difficult task when there are noises around.
2. When I need to concentrate and solve a problem, I have trouble focusing my attention.
3. When I am working hard on something, I still get distracted by events around me.
4. My concentration is good even if there is music in the room around me.
5. When concentrating, I can focus my attention so that I become unaware of what's going on in the room around me.
6. When I am reading or studying, I am easily distracted if there are people talking in the same room.
7. When trying to focus my attention on something, I have difficulty blocking out distracting thoughts.
8. I have a hard time concentrating when I'm excited about something.
9. When concentrating I ignore feelings of hunger or thirst.
10. I can quickly switch from one task to another.
11. It takes me a while to get really involved in a new task.
12. It is difficult for me to coordinate my attention between the listening and writing required when taking notes during lectures.
13. I can become interested in a new topic very quickly when I need to.
14. It is easy for me to read or write while I'm also talking on the phone.
15. I have trouble carrying on two conversations at once.
16. I have a hard time coming up with new ideas quickly
17. After being interrupted or distracted, I can easily shift my attention back to what I was doing before.
18. When a distracting thought comes to mind, it is easy for me to shift my attention away from it.
19. It is easy for me to alternate between two different tasks.
20. It is hard for me to break from one way of thinking about something and look at it from another point of view.

Bewegend leren - leidraad

In deze bundel staat alle praktische informatie samengebundeld die jullie nodig zullen hebben voor het uitvoeren van het bewegend leren onderzoek.

1. Trainingsschema

Bewegend leren – al zittend met/zonder materiaal

1. Actief onderwijsleergesprek

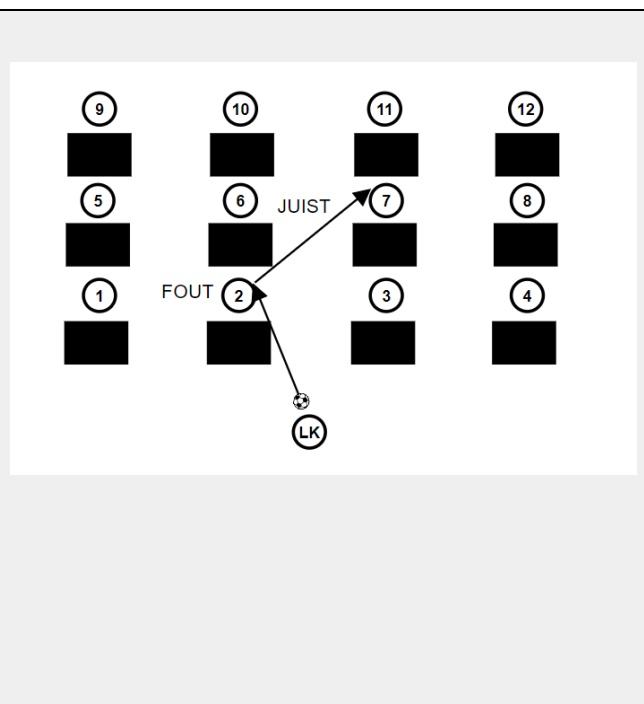
Beginsituatie: Lln zitten achter hun bureau in de klas – lkr neemt vooraan plaats met een bal in zijn/haar handen.

Uitleg: Lkr stelt een vraag omtrent de geziene leerstof en werpt de bal naar lln 1. Lln 1 geeft een antwoord op de vraag.

Bij een fout antwoord houdt lln 1 de bal bij en antwoordt deze op de volgende vraag.

Bij een juist antwoord gooit lln 1 de bal naar lln 2. Lln 2 antwoordt op zijn/haar beurt op de vraag.

Materiaal: zacht voorwerp (bv bal).
Tijd: 10-15 min

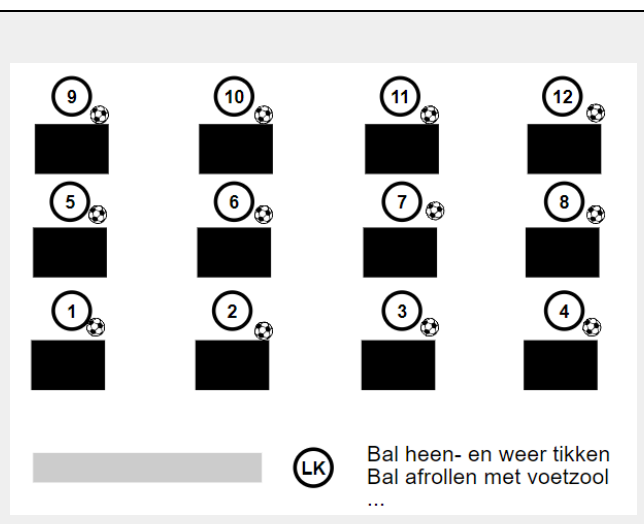


2. Voetbal onder tafel

Beginsituatie: Lln zitten achter hun bureau in de klas – lkr neemt vooraan plaats en doceert de les.

Uitleg: Lln hebben een bal tussen de voeten waarmee ze telkens een dribbelende beweging maken (bal beweegt rustig van links naar rechts tussen de voeten). Deze beweging blijven ze continu uitvoeren.

Materiaal: Bal
Tijd: 5-50min



3. Creatieve stoelen

Beginsituatie: LIn ruilen hun stoel in voor een zitbal.

Uitleg: LIn zitten gedurende de hele les op een zitbal.

Materiaal: Zitbal

Tijd: 50min



Figuur 1 beweegklas.nl

4. Fietsbureau

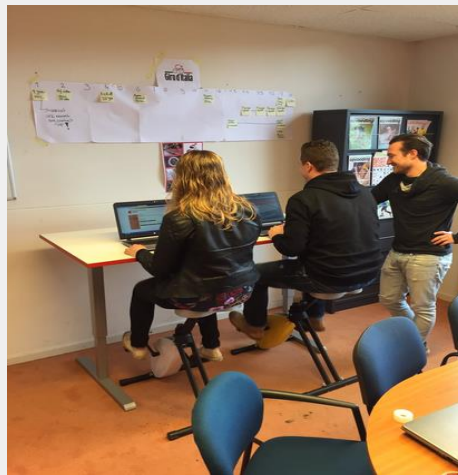
Beginsituatie: LIn ruilen hun stoel in voor een fietsbureau.

Uitleg: LIn nemen gedurende heel de les plaats achter de fietsbureau.

Hierbij fietsen ze en tegelijkertijd wordt de leerstof gedoceerd.

Materiaal: Fietsbureau

Tijd: 50min



Figuur 2 beweegklas.nl

5. Al zittend bewegen

Beginsituatie: LIn zitten achter hun bureau in de klas.

Uitleg: LIn bewegen met hun ledematen terwijl ze op hun stoel zitten.

Voorbeelden:

- LIn bewegen de hiel op en neer terwijl de tenen op de grond blijven
- LIn bewegen knieën op en neer
- ...

Materiaal: Geen

Tijd: 10-50min



www.istockphoto.com

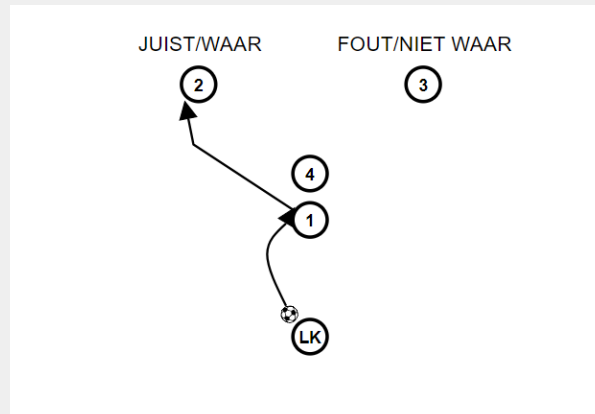
Bewegend leren – rechtstaand zonder extra materiaal

1. Reactiesnelheid

Beginsituatie: Lkr staat oog in oog met lln 1. Achter lln 1 staan nog 2, 3 of 4 lln. Elke lln correspondeert met een antwoord (bv. juist/fout vragen: lln 2 = juist, lln 3 = fout).

Uitleg: Lkr stelt vraag aan lln 1. Als lln 1 het juiste antwoord denkt te weten, gooit lln 1 de bal naar één van de andere lln achter hem/haar. Bij fout antwoord blijft lln 1 staan en krijgt deze nieuwe vraag van de lkr. Bij een juist antwoord, vervoegt lln 1 de andere lln en schuift lln 2 door naar de positie van lln 1. Deze acties dienen vlot en snel te gebeuren.

Tijd: 10-50min



2. Woorden uitbeelden

Beginsituatie: Lkr doceert theoretische leerstof (bv. aardrijkskunde - landen, steden, ... ; biologie - anatomie, plantensoorten, diersoorten, ... ; taalvakken - woordenschat, ...)

Uitleg: Bepaalde woorden of begrippen die moeten worden geleerd, worden uitgebeeld door de lln.

Bv. lkr Engels toont het woord 'dog' en lln beelden een hond uit.

Tijd: 5-50min



Figuur 3 woordenjacht.nl

3. Bewegende stoelen

Beginsituatie: Onderwijsleergesprek

Uitleg:

Op voorhand spreekt de lkr met de lln af dat een bepaalde houding op de stoel gekoppeld is aan een bepaald antwoord.

Bv. Les economie met topic 'verschillende sectoren' waarover de lkr een vraag stelt. lln antwoorden op deze vraag a.d.h.v. de houding op hun stoel:

Primaire sector = op de stoel zitten

Secundaire sector = op de stoel staan

Tertiaire sector = achter de stoel staan

Quartaire sector = naast de stoel staan

Tijd: 5-15min



4. Actieve Kahoot Quiz

Beginsituatie: Bij aanvang of einde van de les, geeft de lkr een Kahoot quiz. Als startpositie, staan de lln recht op hun stoel.

Uitleg: De lkr stelt een vraag via de Kahoot quiz en lln antwoorden via hun smartphone. Indien de lln de vraag fout hebben beantwoord, gaan ze in squathouding naast de stoel staan tot ze de volgende vraag hebben beantwoord. Indien de lln de vraag juist hebben beantwoord, stappen ze op en af hun stoel. Deze acties dienen vlot en snel te gebeuren.

Tijd: 5-15 min



Figuur 4 goedetengezondleven.nl

5. Leerstof koppelen met doe-opdrachten

Beginsituatie: LIn positioneren zich rechtstaand achter hun stoel.

Uitleg: Lkr stelt een klassikale vraag over de leerstof en koppelt dit met een 'doe-opdracht': LIn mogen enkel hun boven- of onderlichaam bewegen. Telkens de lkr een vraag stelt, bewegen de lIn met hun lichaam en denken na over een antwoord. Bij een volgende vraag, maken ze een nieuwe beweging – opnieuw enkel met boven- of onderlichaam.

Tijd: 5-50 min



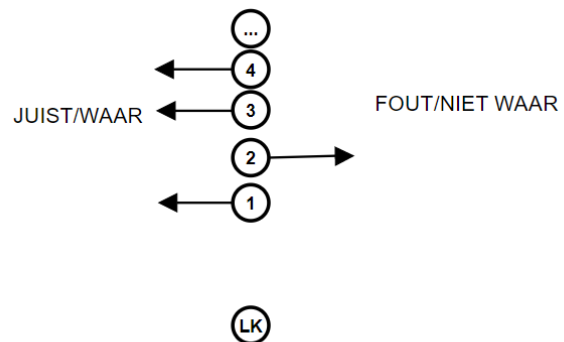
6. Bewegende rijen

Beginsituatie: Lkr staat centraal vooraan en voor de lIn die een rij achter elkaar vormen. Op voorhand wordt met de lIn afgesproken dat een bepaalde beweging correspondeert met een bepaald antwoord (bv. juist/fout vragen: naar links springen = juist, naar rechts springen = fout).

Uitleg: Lkr stelt een vraag en de lIn maken zo snel mogelijk een sprong naar links of naar rechts. LIn vooraan sluit zo snel mogelijk aan achteraan. Lkr stelt de volgende vraag. Deze acties dienen vlot en snel te gebeuren.

OF lIn staan op één rij. Bij juist springen alle leerlingen op hetzelfde moment (aftellen) naar links, bij fout springen alle leerlingen op hetzelfde moment naar rechts.

Tijd: 5-20 min



7. Fitness met een stoel

Beginsituatie: Lkr toont een videofragment tijdens de les.

Uitleg: Bij het tonen van het videofragment, voeren de lln fitness oefeningen uit met hun stoel.
Bv. op en af de stoel stappen, squat op of naast de stoel, pompen met de handen op stoel, ... Na het videofragment, maken de lln een samenvatting van de video of bekomen ze een vragenlijst die ze dienen in te vullen.

Tijd: 10-50 min



Bewegend leren – rechtstaand met extra materiaal

1. Actieve buitenles

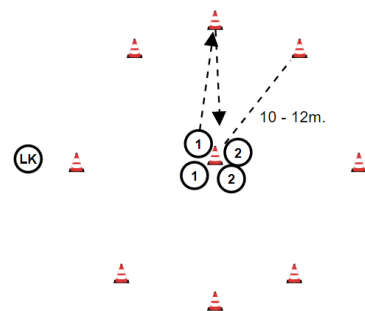
Beginsituatie: lln volgen de les buiten. Centraal wordt een startkegel geplaatst.

Uitleg: 10 à 15m verder worden verschillende eindkegels geplaatst die een grote buitencirkel vormen.

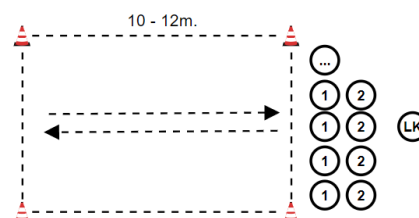
2 lln staan in duo tegenover elkaar bij de startkegel. lln 1 stelt een vraag aan lln 2 i.v.m. de leerstof. lln 2 loopt van de startkegel naar de eindkegel en terug – tijdens deze periode heeft deze lln de kans om een antwoord te geven op de vraag.

Bij een juist antwoord, wordt meteen de volgende vraag gesteld. Bij een fout antwoord moet lln 2 opnieuw dezelfde afstand lopen. Na 5 vragen wisselen de lln van positie.

Materiaal: Kegels of voetbal pionnen
 Tijd: 10-20 min



OF



2. Actieve buitenles 2

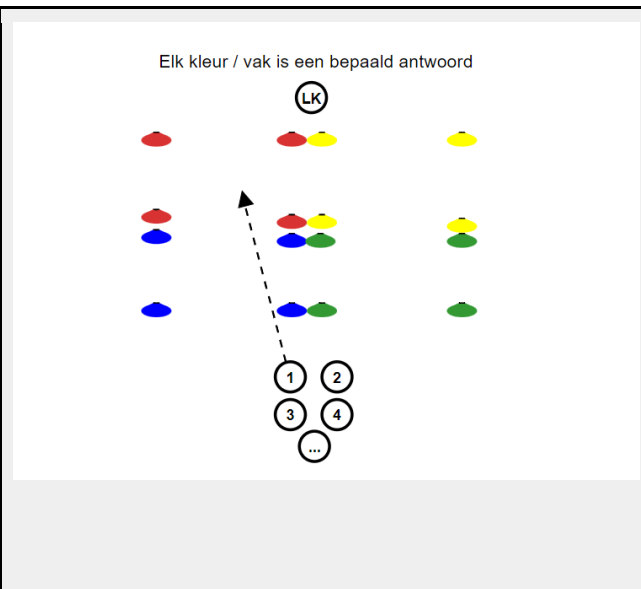
Beginsituatie: Lln volgen de les buiten. De 'ruimte' wordt opgedeeld in vier verschillende hoeken met bv. kegels. Centraal in de ruimte staat 1 kegel ge-positioneerd.

Uitleg:

Elke hoek representeert een bepaald antwoord (bv. juist of fout, meerkeuze antwoorden, ...). De lln en lkr staan/starten centraal. De lkr leest een vraag voor en de lln lopen naar de 'juiste' hoek.

Materiaal: 5 kegels

Tijd: 5-15min



3. Actief onderwijsleergesprek

Beginsituatie: Lln staan recht in de klas – lkr neemt vooraan plaats met een bal in zijn/haar handen.

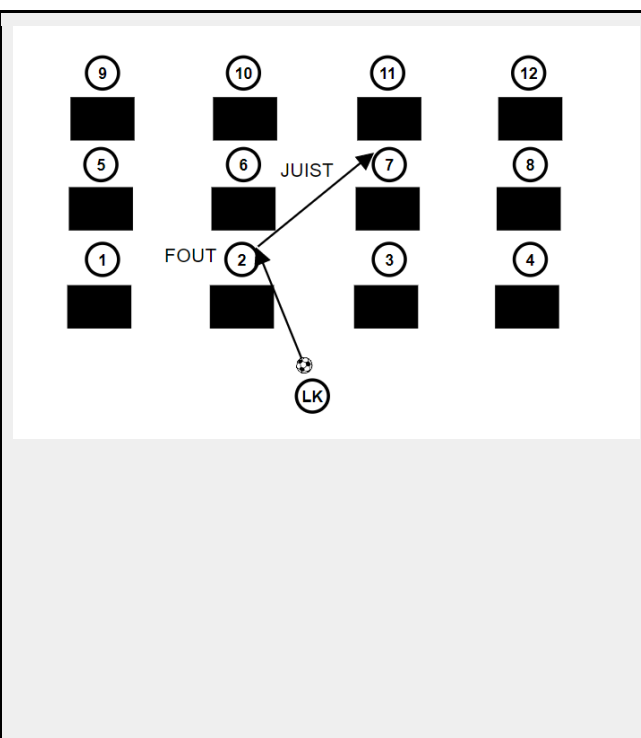
Uitleg: Lkr stelt een vraag omtrent de geziene leerstof en werpt de bal naar lln 1. Lln 1 geeft een antwoord op de vraag.

Bij een fout antwoord houdt lln 1 de bal bij en antwoordt deze op de volgende vraag.

Bij een juist antwoord gooit lln 1 de bal naar lln 2. Lln 2 antwoordt op zijn/haar beurt op de vraag.

Materiaal: zacht voorwerp (bv bal).

Tijd: 10-15 min



4. Actief onderwijsleergesprek 2

Beginsituatie: Lkr staat centraal vooraan en voor de lln die een rij achter elkaar vormen.

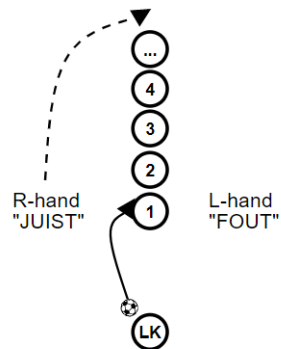
Uitleg: Lkr stelt een juist/fout vraag en gooit een bal naar de lln die vooraan staat. De lln vangt de bal in de linkerhand als hij/zij denkt dat het antwoord juist is. De lln vangt de bal in de rechterhand als hij/zij denkt dat het antwoord fout is.

Bij een fout antwoord blijft de lln staan, bij een juist antwoord schuift de lln door naar achter. Deze acties dienen vlot en snel te gebeuren.

Materiaal: Zachte bal

Tijd: 5-15min

Variatie: Meerkeuze vragen



5. Actieve PowerPoint presentatie

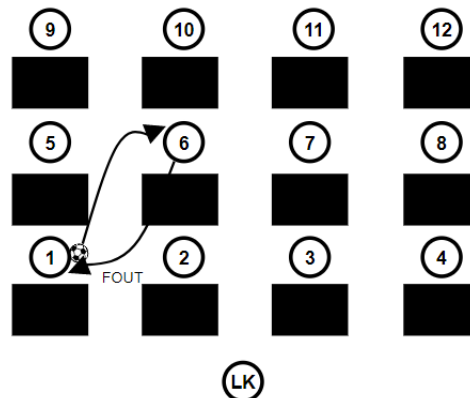
Beginsituatie: Lkr maakt gebruik van een PowerPoint presentatie. Op elke dia staat één vraag vermeld.

Uitleg: lln 1 heeft een bal in zijn/haar handen en leest de vraag van de dia luidop voor. Hij/zij noemt de naam van de persoon waarnaar hij/zij de bal gooit. Tijdens het gooien van de bal, geeft lln 1 een antwoord op de vraag. Bij een foute vraag, wordt de bal teruggeworpen naar lln. Deze acties dienen vlot en snel te gebeuren.

Materiaal: Zachte bal

Tijd: 10-20 min

Variatie: Bij een foutief antwoord voert lln 1 fitness oefeningen uit tot lln 2 een antwoord heeft gegeven op zijn/haar vraag.

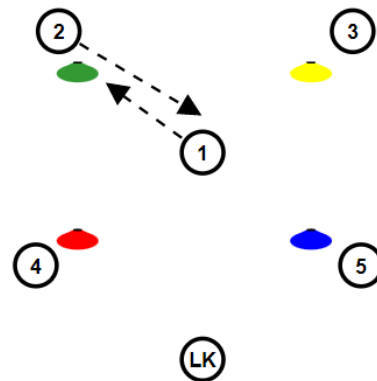


6. Cirkel vragen

Beginsituatie: Er worden groepjes Iln gevormd waarvan één groepje bestaat uit 5 Iln. Hiervan staat één Iln centraal met 4 Iln rond zich. Van deze 4 Iln heeft elks een gekleurd kegeltje voor zich staan. Elke kleur staat correspondeert met een bepaald antwoord (wordt op voorhand afgesproken tussen Iln en lkr). De lkr staat buiten de groepjes Iln.

Uitleg: Lkr stelt een vraag over de leerstof. De Iln die centraal staat (Iln 1) dient zo snel mogelijk te antwoorden door naar de juiste kegel te lopen waar Iln 2 staat. Nadien wisselen Iln 1 en 2 van positie zodat elke Iln aan de beurt komt om te antwoorden op een vraag. Deze acties dienen vlot en snel te gebeuren.

Materiaal: Kegels of voetbal pionnen
Tijd: 10-20 min
Variatie: Indien een Iln een fout antwoord geeft, voert hij/zij fitness oefeningen uit tot de volgende Iln op een vraag heeft geantwoord.



7. Loopband met bureau

Beginsituatie: Iln ruilen hun stoel in voor een loopband waarvan een rechtstaande bureau kan worden gemaakt.

Uitleg: Iln nemen gedurende heel de les plaats op de loopband. Hierbij wandelen ze en tegelijkertijd wordt de leerstof gedoceerd door de lkr.

Materiaal: Loopband bureau
Tijd: 50min



Figuur 5 bol.com

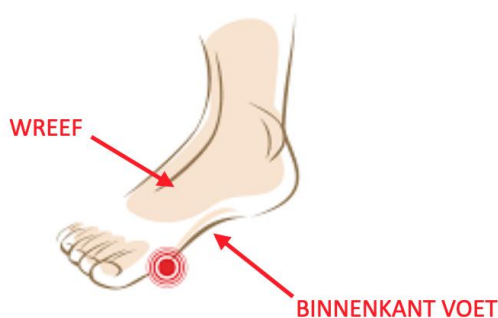
8. Senseball

De senseball trainingen bestaan uit verschillende reeksen die 10-50 minuten kunnen duren.

YouTube video training met Frank Kerkhofs: https://youtu.be/x_kN7aV6a7g

Reeks 1 : Initiatie	Senseball in rechterhand nemen. Bal zwaaien naar links en rechts op een rustig tempo. Als de bal naar rechts zwaait, rechtervoet vooruit plaatsen. Hierna voet terugplaatsen op normale positie. Herhalen met linkerhand en linkervoet.
	Senseball in rechterhand nemen. Bal zwaaien naar links en rechts op een rustig tempo. Als de bal naar rechts zwaait, rechtervoet achteruit plaatsen. Hierna voet terugplaatsen op normale positie. Herhalen met linkerhand en linkervoet.
	Senseball in rechterhand nemen. Bal zwaaien naar links en rechts op een rustig tempo. Als de bal naar rechts zwaait, rechtervoet vooruit plaatsen. Als de bal naar links zwaait, rechtervoet achteruit plaatsen. Herhalen met linkerhand en linkervoet.
	Senseball in rechterhand nemen. Bal zwaaien naar links en rechts op een rustig tempo. Als de bal naar rechts zwaait, linkervoet schuin vooruit plaatsen. Als de bal naar links zwaait, bij stappen. Herhalen met linkerhand en linkervoet.
	Senseball in rechterhand nemen. Bal zwaaien naar links en rechts op een rustig tempo. Als de bal naar rechts zwaait, linkervoet schuin achteruit plaatsen. Als de bal naar links zwaait, bij stappen. Herhalen met linkerhand en linkervoet.
	Senseball in rechterhand nemen. Bal zwaaien naar links en rechts op een rustig tempo. Als de bal naar rechts zwaait, linkervoet schuin vooruit plaatsen. Als de bal naar links zwaait, bij stappen. Als de bal naar rechts zwaait, linkervoet schuin achteruit plaatsen. Als de bal naar links zwaait, bij stappen. Herhalen met linkerhand en linkervoet.
	Reeks 2 : Binnenkant voet
Senseball in rechterhand nemen. Afwisselend met de binnenkant van de rechter- en linkervoet 2x tikken tegen de bal.	
Senseball in rechterhand nemen. Tikken met de binnenkant van de rechtervoet tegen de bal. Trippelen met de voeten. Tikken met de binnenkant van de linkervoet tegen de bal herhalen.	
Herhaal de bovenstaande oefeningen met de Senseball in de linkerhand te nemen en te tikken met de binnenkant van de	

	linkervoet tegen de bal.
Reeks 3 : Wreef	Senseball in rechterhand nemen. Afwisselend met de wreef van de rechter- en linkervoet tikken tegen de bal.
	Senseball in rechterhand nemen. Afwisselend met de wreef van de rechter- en linkervoet 2x tikken tegen de bal.
	Senseball in rechterhand nemen. Tikken met de wreef van de rechtervoet tegen de bal. Trippelen met de voeten. Tikken met de wreef van de linkervoet tegen de bal. Herhalen.
	Herhaal de bovenstaande oefeningen met de Senseball in de linkerhand te nemen en te tikken tegen de bal met de linkervoet.
Reeks 4 : Binnenkant voet en wreef	Senseball in rechterhand nemen. Tikken met binnenkant rechtervoet en tikken met wreef rechtervoet tegen bal. Herhaal met linkervoet.
	Senseball in rechterhand nemen. 2x tikken met binnenkant rechtervoet en 2x tikken met wreef rechtervoet tegen bal. Herhaal met linkervoet.
	Senseball in rechterhand nemen. Tikken met binnenkant rechtervoet tegen bal. Trippelen met de voeten. Tikken met de wreef van de rechtervoet tegen de bal. Herhaal met linkervoet.
Reeks 5 : Binnenkant voet - achterwaarts	Senseball in rechterhand nemen. Tikken met binnenkant rechtervoet achterwaarts tegen de bal. Tikken met binnenkant linkervoet achterwaarts tegen de bal.
Reeks 6 : Binnenkant voet - stappen	Senseball in rechterhand nemen. Afwisselend met de binnenkant van de rechter- en linkervoet tikken tegen de bal en terwijl voorwaarts stappen.
Reeks 7 : Wreef - stappen	Senseball in rechterhand nemen. Afwisselend met de wreef van de rechter- en linkervoet tikken tegen de bal en terwijl voorwaarts stappen.
Reeks 8 : Binnenkant voet en wreef - stappen	Senseball in rechterhand nemen. Tikken met binnenkant rechtervoet en tikken met wreef rechtervoet tegen bal en terwijl voorwaarts stappen. Herhaal met linkervoet.



Supplemental 6: Question guideline drafted in Dutch.

Focusgroep zelf:

- Foto's/post-its meebrengen (POST_IT foto's nummeren voor volgorde!) + voice recorder
- Ontvangst
 - Check de ruimte van te voren en plaats de stoelen in een kring. Check de opname apparatuur. De gespreksleider en de assistent zorgen er voor zij dat zij als eerste aanwezig zijn om de deelnemers op te vangen.
- Introductie
 - Heet iedereen welkom, bedank de deelnemers voor hun komst, stel jezelf en de assistent voor.
 - Vraag de namen van de deelnemers + aantal jaren ervaring leerkrachten.
 - Licht het onderwerp en het doel van de bijeenkomst kort toe.
 - > "Tijdens deze focusgroep gaan we vragen stellen over hoe jullie het onderzoek van bewegend leren hebben ervaren. Ons doel hiervan is om na te gaan of bewegend leren iets haalbaars is om toe te passen in de klas en of het al dan niet bevorderlijk is voor jullie."
 - Zeg dat je geïnteresseerd bent in de ervaringen en meningen van de deelnemers in relatie tot het onderwerp en dat deze belangrijk zijn.
 - Vertel hoe lang de bijeenkomst duurt (ongeveer 1 uur) en we eventueel een korte pauze voorzien. Geef aan dat er een anoniem verslag gemaakt wordt van de bijeenkomst, dat het voor de verslaglegging nodig is om geluids- of video-opnames te maken en vraag hier toestemming voor.
 - Overloop afspraken: niet door elkaar praten, met respect naar elkaar luisteren.
 - Leg uit dat alle ervaringen, meningen en ideeën even belangrijk zijn en dat de deelnemers het niet met elkaar eens hoeven te worden. Ook aangeven dat ze met elkaar mogen discussiëren.
- Vragen
 - "We gaan starten met vragen over het onderzoek waarbij we jullie leermethode hebben gefilmd en jullie informatie hebben genoteerd op post-its".
 -
 - "We hebben een aantal voorbeelden van post-its bij. Waarom vind je deze ruimte/materiaal ...
 - Positief/stimulerend
 - Negatief/belemmerend...Om aan bewegend leren te doen?"
 - "Wat maakt een klas wel of niet geschikt om aan BL te doen?" -> "Waarom?"
 - "Welke ruimte, uitgezonderd de klas, op jouw school is geschikt of niet geschikt om aan BL te doen?" -> "Waarom?"

- "Stel, jij hebt alle vrijheid en alle materialen ter beschikking: Welke elementen/materialen bevat jouw ideale klas of school om meer aan beweging te kunnen doen? Dit mag heel breed zijn!"
- "Nu gaan we over naar vragen die betrekking hebben op de 3 weken waarbij jullie aan bewegend leren hebben gedaan in de klas."
- "Hoe bekend was je met bewegend leren voor het onderzoek?"
- "Hoe vaak deed je aan beweging tijdens de les voor de start van het onderzoek?"
-
- "Kan je een paar voorbeelden geven hoe je aan bewegend leren hebt gedaan tijdens het onderzoek?"
- "Welke andere vormen van BL zou je nog willen doen?"
- "Als je BL leuk vond, wat maakte dat je dit leuk vond?"
- "Als je BL niet aangenaam/leuk vond, aan wat was dit te wijten?"
- "Hoe heeft BL jouw leerproces beïnvloedt?"
- "Hoe heeft BL een invloed gehad op hoe jij jou voelde op school, bijvoorbeeld tijdens de les?"
- "Waarom zou je nog wel aan BL willen doen in de toekomst?"
- "Hoe ervaar je het als leerkracht om BL te koppelen met je leerstof? Extra voorbereiding?"
- "Ervaren jullie beweging in de klas als iets haalbaar? -> "Wat maakt het haalbaar of niet haalbaar?"
- "Andere opmerkingen?"

- Doorvragen is een techniek om vage uitspraken en commentaren te verduidelijken. Bruikbare vragen bij deze techniek zijn:
 - Wat bedoelt u met ...?
 - Dat is interessant. Kunt u daar meer over vertellen?
 - Kunt u een voorbeeld noemen van wat u bedoelt?
 - Wat maakt dat u dat zo voelt?
 - Ik begrijp het niet helemaal. Kunt u het uitleggen?
 - Is dat belangrijk voor u?

- Afsluiten
 - Bedank de deelnemers voor hun bijdrage en geef een samenvatting of een korte positieve indruk van de bijeenkomst.
 - Geef aan wat er met de resultaten van de bijeenkomst gebeurt
 - Uitreiken attentie

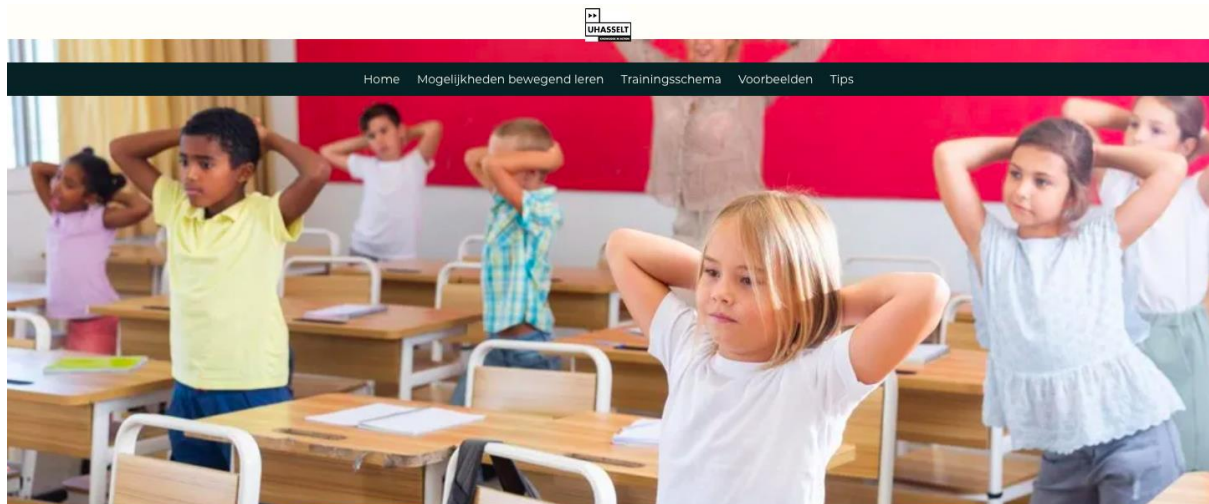
Supplemental 7: Code book qualitative analysis.

Name	Description	Files	References
Embodied learning standing with material	Form of embodied learning in which one stands upright, and additional materials are used.		
Ball	Embodied learning standing with a ball (football, tennis ball,...).	5	21
Bicycle desk	Embodied learning standing with a bicycle desk.	5	11
Treadmill	Embodied learning standing with a treadmill.	3	5
Aerobic step	Embodied learning standing with an aerobic step.	1	2
Punching bag	Embodied learning standing with a punching bag.	1	2
Gaming	Embodied learning standing through gaming (WII sports, XBOX, ...).	1	2
Cones	Embodied learning standing with cones.	1	2
Kernel cushion	Embodied learning standing with a kernel cushion.	1	1
Trampoline	Embodied learning standing with a trampoline.	1	1
Walking desk	Embodied learning standing with a walking desk.	3	4
Game format	Embodied learning standing through a game format.	1	2
Andere materiaal	Embodied learning standing with materials other than those described above.	1	2
Embodied learning standing without material	Form of embodied learning in which one stands upright without usage of additional material, except for a standard table and chair.		
Active kahoot quiz	Teacher asked a question through a kahoot quiz. Students can answer through their smartphones. When answered incorrectly, students take a squat stance until the following question is answered. When answering a question correctly, students get on and of their chairs.	1	1
Moving arms	Students are standing upright whilst moving their arms. In the meantime, the teacher is teaching the class and/ or is asking questions.	1	1
Moving rows	The teacher is at the front center. Students form a row one after the other. In advance it is agreed with the students that a certain movement corresponds to a certain answer (e.g., right/ wrong questions: jumping to the left = right, jumping to the right = wrong). The teacher asks a question, and the students jump as quickly as possible to the left or right.	1	1
Walking	Walking while learning at the same time, through a textbook, notes,...	1	1
Others	Other forms – not clearly specified – of embodied learning standing without material.	5	15
Embodied learning seated	Form of embodied learning in which one is seated. Additional material may or may not be used for this purpose.		
Ball	Embodied learning seated with a ball (football, tennis ball, senseball,...).	4	27
Rubber band	Embodied learning seated with a rubber band.	3	6
Sitting ball	Embodied learning seated with a sitting ball.	6	19
Kernel cushion	Embodied learning seated with a kernel cushion.	1	1
Stepper/pedalo	Embodied learning seated with a stepper.	1	3
Wobble stool	Embodied learning seated with a wobble stool.	3	6
No material	Embodied learning seated without material.	2	4

Final conclusion	Synthesis of the information collected at the end of the focus group discussion.	3	3
Learning process	Influence of embodied learning on learners' acquisition of knowledge and skills.		
Concentration	The ability to focus attentively or not on the lesson.	7	40
Learning	Change in knowledge or skills influenced by embodied learning.	7	22
Stimuli	Information absorbed through the senses and, in the context of current research, are perceived as impeding the learning process. Stimuli can be experienced internally (feelings and emotions) as well as externally (seeing, hearing, smelling, feeling).	5	14
Variation	The variety of opportunities for embodied learning during the lesson that relate to the learners' learning process.	1	1
Review of subject matter	Embodied learning used as a teaching form to repeat learning.	1	7
Prior knowledge of embodied learning	What may or may not already be known about embodied learning.		
Embodied learning known	Teachers/ students are known with embodied learning.	2	2
Embodied learning unknown	Teachers/ students are not known with embodied learning.	2	2
Brain breaks	Brief moments of interruption during the lesson through a movement activity with the aim of sharpening attention again.	4	7
Teacher well-being	Sense of well-being experienced by teachers during the research period of embodied learning.		
Target group class	The teacher speaks on behalf of the students about their well-being during the intervention.	7	31
Feasibility embodied learning	Factors that were perceived as hindering or facilitating teachers from engaging in embodied learning.	5	38
Intensity	How much time was spent on embodied learning in one lesson time - whether a difference was noticed at the start of the intervention vs. at the end of the intervention.	1	1
Curriculum	How it was experienced to link embodied learning to the curriculum.	7	14
Enthusiasm	Teacher's enthusiasm to use embodied learning in his/her lesson.	2	2
Group spirit	The teacher talks about the sense of bonding (student-teacher and student-student relationship) during embodied learning in his/her lesson.	3	3
Motivation	The teacher talks about his/her own intrinsic motivation to engage in movement learning.	2	3
Student well-being	Sense of well-being experienced by students during the study period of embodied learning.		
Enthusiasm	The enthusiasm that students experience while performing embodied learning during class.	6	29
Feasibility embodied learning	Whether or not embodied learning is feasible during the lesson, taking into account space, environment, lesson content, time frame,...	7	14

Motivation	Students talk about their own intrinsic motivation to engage in movement-based learning.	6	18
Group spirit	Students talk about the sense of bonding (pupil-teacher and pupil-pupil relationship) they experience when implementing the intervention.	5	5
Variation	The variety of opportunities for embodied learning during the lesson that relate to students' well-being.	4	15

Supplemental 8: Creative end-product. Website drafted in Dutch with URL-link: <https://lizeputzeys.wixsite.com/bewegend-leren>.



Bewegend leren

Over

Wij zijn drie studenten van de opleiding Educatieve Master aan de UHasselt die een masterproef maakten over het onderwerp bewegend leren. Hanne, vooropleiding Kinesitherapie, Pediatrie (2013) en toegewijde mama van 2 jonge zontjes. Lize, vooropleiding Kinesitherapie, MSK (2022) en tophandbalster in hart en nieren. Kúbra, vooropleiding Biomedische wetenschappen (2022) en trotse kat-mama van Simba. Deze website dient dan ook als creatief eindproduct voor onze masterproef genaamd; "Embodied learning in adolescents: analyzing well-being and possibilities"





"Na het bewegend leren merkte ik bij de leerlingen een betere focus, ze waren rustiger en toonden meer energie bij de gevraagde opdrachten."

Leerkracht 1



"Ik heb echt genoten van het bewegend leren. Het niet constant stil te moeten zitten vond ik heel leuk."

Leerling



"Ik vind bewegend leren op zich wel leuk om te doen, maar alles moet zich daartoe lenen. Het hangt van het moment van de dag, de groep en de les af."

Leerkracht 2



Dra. Lindsay Everaert

Supervisor



Prof. dr. Wim Tops

Promotor



Prof. dr. Anouk Achten

Promotor



Dr. Ruth Stevens

Promotor



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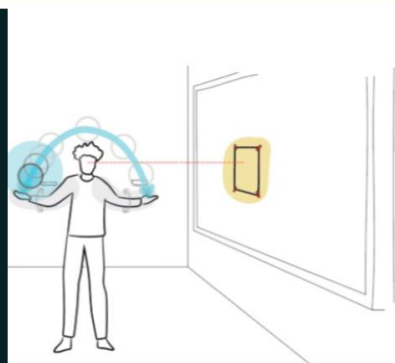
Bewegend leren

Bewegend leren is de leerstof aanleren of verwerken door bewegingen te maken. Deze bewegingen moeten in functie van het einddoel zijn en functioneel worden ingevuld waardoor de beweging het kind helpt en de leerstof in het lichaam vertaald wordt. Door te bewegen kan je je beter concentreren waardoor het leervermogen stijgt. Ook worden de zintuigen geprikkeld waardoor het leren beter gaat. Deze manier van lesgeven voldoet aan de bewegingsdrang die kinderen in zich hebben. Wanneer de leerstof wordt ervaren met hun lichaam blijft de leerstof beter hangen. Het is bewezen dat kinderen die meer sporten ook betere prestaties behalen. Uit onderzoek blijkt dat bewegen er voor zorgt dat bepaalde stoffen in de hersenen vrijkomen.



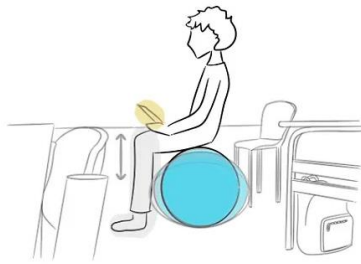
Zittend met of zonder materiaal

Bij deze mogelijkheid van bewegend leren worden bewegingsvormen al zittend aangereikt. Extra materiaal kan hiervoor gebruikt worden maar is geen noodzaak.



Rechtstaand zonder materiaal

Bij deze mogelijkheid van bewegend leren worden bewegingsvormen aangereikt waarbij men rechtstaat en er geen extra materiaal met uitzondering van de stoel en de tafel gebruikt wordt.



Rechtstaand met extra materiaal

Bij deze mogelijkheid van bewegend leren worden bewegingsvormen aangereikt waarbij men rechtstaat en er extra materiaal gebruikt wordt.

Afbeeldingen met dank aan: Michelle Carolus, Donna Weckhuizen, Jente Mellemans, Adrianna Kucinska, Lies Van den Broeck en Emma Daemen

Studenten 2e bachelor verbonden aan de Faculteit Architectuur en Kunst.



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Trainingsschema

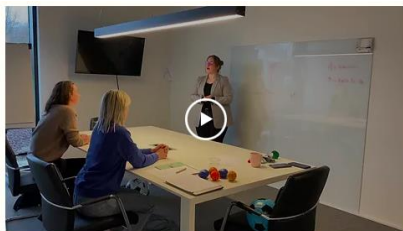
Het trainingsschema kunt u als pdf downloaden door te klikken op het icoontje.



PDF

Voorbeelden

Hieronder kunt u enkele illustratieve video's ter verduidelijking van bewegend leren terugvinden. Deze video's zijn een verduidelijking van de oefeningen in het trainingsschema.



01

Bewegende stoelen

Bewegend leren rechtstaand zonder extra materiaal.

02

Voetbal onder tafel + al zittend bewegen

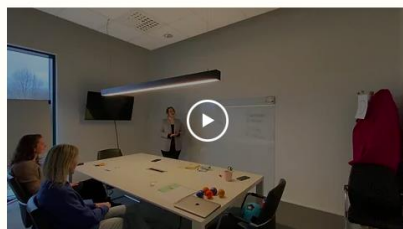
Bewegend leren al zittend met of zonder extra materiaal.



03

Cirkel vragen

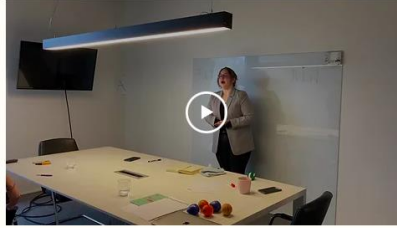
Bewegend leren rechtstaand met extra materiaal.



04

Bewegende rijen

Bewegend leren rechtstaand zonder extra materiaal.



05

Actief onderwijsleergesprek

Bewegend leren rechtstaand met extra materiaal.



06

Actief onderwijsleergesprek

Bewegend leren al zittend met of zonder extra materiaal.



07

Variatie actief onderwijsleergesprek

Bewegend leren al zittend met of zonder extra materiaal.

Tips



7 Tips om aan bewegend leren te doen.

1. Bereid op voorhand uw les goed voor.
2. Zorg dat u het materiaal hebt klaarliggen in uw klaslokaal.
3. Breng variatie.
4. Uit onderzoek bleek dat leerlingen graag met een bal werken, dit kan hen extra motiveren.
5. Maak duidelijke afspraken met de leerlingen voor aanvang van bewegend leren.
6. Om leerstof te herhalen zijn spelvormen een goede motivator.
7. Voor het aanreiken van nieuwe leerstof kan u best gebruik maken van de zittende mogelijkheid voor bewegend leren.

