

Article

# The Impact of Flipped Learning on Cognitive Knowledge Learning and Intrinsic Motivation in Norwegian Secondary Physical Education

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**Abstract:** The purpose of the present study was to examine if and how the introduction of a flipped learning (FL) framework in Norwegian lower and upper secondary school physical education (PE) could affect student situational motivation and health-related fitness knowledge (HRFK). 206 Norwegian students (48% girls) from secondary and upper secondary schools were included in a three-week-long intervention. 85 students were assigned to an intervention group and 121 students to a control group, with the intervention aimed at integrating information communication technology (ICT) through the use of online videos. The results showed a negative motivational change for male students unless the activity changes were placed within an explanatory rationale through FL. The application of FL caused more cognitive knowledge learning, resulting in higher levels of HRFK among both girls and boys. The current research provided valuable insights into Norwegian students' motivation for PE and that cognitive knowledge learning can be affected when integrating the use of ICT in PE.

**Keywords:** flipped learning; flipped classroom; motivation; learning; physical education

## 1. Introduction

In the Norwegian curriculum of physical education (PE), an important goal is to provide students with the necessary knowledge and motivation to ensure that participation in PE should translate into a life-long participation in physical activity (PA) [1]. Motivation for participation in PE is considered important as motivation has, theoretically and empirically, been linked to several positive outcomes, such as intentions to be physically active outside of class [2–5]. Such research lends support to the trans-contextual model suggested by Hagger et al. [6], in which an autonomy-supportive teacher style creates autonomous motivation and leisure time PA among students, suggesting that PE may play a role in shaping young people's beliefs and behavior concerning PA outside school hours. Physical activity promotes physical and mental health, and is an important and well documented way of preventing and treating over 30 different diagnoses and conditions [7]. Thus, participation in PE is often connected to worries concerning the physical activity level of the population. For instance, only 34% of European adolescents aged 13–15 years are active enough to meet the current guidelines of 60 minutes of moderate physical activity per day [8], and in the USA only 27.1% meet these recommendations [9]. Norwegian 15-year-olds appear to reach a higher level of physical activity level, with 40% of girls and 51% of boys reaching the recommended level, but the time that 15-year-olds spend sitting still (sedentary time) has risen to about nine hours of their time awake [10].

However, research also shows that students experience barriers to participating in PE, such as peer pressure and boys' dominance, and have negative feelings towards participation [11,12]. Internationally, and including Norway, PE is stated to be too dominated by sports-like activities [13–15], and that boys and students who conduct sport outside schools benefit most from the subject [16–23]. Such issues might explain why PE does not seem to complete the given aim of inspiring all children to be active and to promote a life-long healthy lifestyle, either in Norway [15,18] or internationally [24,25].

It is also important to acknowledge that there is uncertainty about the subject's educational purpose. Both teachers and pupils have difficulties in articulating what the pupils are supposed to learn in PE, and teachers maintain that the main purpose of PE is to "have fun" [26], or keep the students "happy, busy and good" [27–29], and continue practicing a traditional teacher-centered teaching style [24]. Learning in PE is a complex matter, and, according to Rink [30], PE stands out as a school subject, including learning in the three domains of psychomotor, affective, and cognitive learning. Even though cognitive knowledge learning is important in the curriculum of PE, it has rarely been included as an outcome measure in research [31,32]. Furthermore, studies indicate that the gymnastics hall is not a suitable space for lecturing, as the vigorous context shifts the students' motivation away from cognitive learning, toward physical participation, according to Chen et al. [33]. Nevertheless, Zhu et al. [34] found that middle school students' health-related fitness knowledge (HRFK) was low, but growing linearly throughout middle school, with girls displaying a higher growth rate than boys, when implementing a curriculum tailored to enhance HRFK. Chen and Ennis [35] presented results from an inquiry among elementary school students showing that PE levels do not decline when implementing cognitive learning processes in PE, and this gives support to the mantra of Silverman [36], stating that the goal of teaching is learning, and learning in PE requires more than just activity. There seems to be a need for researchers to change focus from studying activities to studying learning outcomes [26]; and to investigate how students can learn better in PE we need to understand what and how their motivation towards PE is affected.

### 1.1. Motivation

According to self-determination theory (SDT) [37], motivation is a multidimensional construct reflecting different degrees of self-determination. SDT distinguishes between different types of motivation based on the different reasons or goals that give rise to an action. A person's motivation is conceptualized by SDT researchers to vary on a continuum from intrinsic motivation to amotivation. Broadly speaking, the types of motivation that reflect behavioral engagement as a result of enjoyment/task interest (intrinsic motivation (IM)), or integration of a behavior into one's core self and value system (integrated regulation), or due to the perceived personal utility and benefits of the behavior (identified regulation (IR)), have been combined to form autonomous motivation [38]. In disparity, motivations that reflect behavioral engagement stemming from internal pressures such as guilt or ego contingencies (introjected regulation), or external burdens such as rewards or castigations (external regulation (ER)) are named controlled forms of motivation. Organismic Integration Theory (OIT) [39] posits a continuum of different types of motivation, ranging from amotivation (AM) to internal motivation. An important tenet of OIT is that behaviors can start as externally regulated, and then become more internally regulated over time as the behavior is more and more integrated into the sense of self.

In a school context, it is desirable for all students to achieve a high level of engagement in learning activities that can result in a high learning outcome. Ryan and Deci [37] argue that self-determined motivation is high-quality motivation and results in the desirable outcome of engagement. Autonomous motivation is considered an important basis for learning, and students who are autonomously motivated tend to learn better, especially in terms of conceptual understanding [40].

## Motivation in PE

In PE, autonomous motivation would be that students identify with the value of the activity and integrate it into their sense of self, and controlled motivation would be to participate in the activity due to some external reward or punishment (e.g., grades) or internal reward or punishment (e.g., pride or shame). In a recent review of 74 studies applying SDT in PE settings by Van den Berghe et al. [41], support was found for the motivational sequence suggested by SDT, in which student motivation impacts the outcomes in PE and leisure time PA. Such findings are also supported within the Norwegian context, where self-determination in PE has been shown to positively affect adolescents' intentions to be physically active after graduation from high school [42]. There is a clear observation of a decline in motivation to participate in PE with age [18,43,44], especially among girls [15,45]. This decline in motivation must be halted, as learning in school is strongly associated with, and predicted by, motivation [46]. Nevertheless, previous studies have also shown mixed results related to the development of students' motivation related to age. Some studies show a decline in students' internal motivation across the school years, whereas external motivation stays relatively stable [47,48]. There are also examples of internal motivation decreasing and external motivation increasing [49]. Others again show internal motivation to be stable, whereas external motivation increases [50]. Yli-Piipari et al. [50] suggest that stable internal motivation over time might be explained by the highly autonomy supportive environment created by Finnish PE teachers. Labbrozzi et al. [51] found a decline in IM and IR among girls when passing the age of puberty, and that both the levels of IM and IR were highly correlated to the levels of physical activity.

In addition to long term development of motivational regulations, there is also the important issue of short-term fluctuations. Carpentier and Mageau [52] found that the type of feedback used during a training session impacts motivational regulations, and the more autonomy supportive change-oriented feedback athletes received, the higher was the level of autonomous motivation reported following such training sessions. In training interventions, autonomous regulations appear to increase over time, with increases being present already between the baseline and four weeks [53]. It appears that changes in external motivation take a somewhat longer time, with the earliest changes detected six to eight weeks after the baseline [54].

Research concerning participation in PE and cognitive knowledge learning have shown some contradictory results. Sun and Chen [55] found no relationship between intrinsic or extrinsic motivation and students' knowledge learning. There was, however, a significant negative relationship between amotivation and cognitive knowledge gain. In another relevant study, Langdon et al. [56] found students' autonomous motivation positively related to a volleyball cognitive knowledge test score. Sun et al. [32] suggest that the contradictory results might be explained by the clarity of learning goals. When teaching a sport unit like volleyball, PE teachers might give more clear and specific learning goals. Digital technologies can be a facilitator for both enhanced motivation and learning in PE [57]. Rather than dispensing knowledge in PE, digital technology can facilitate the building up of knowledge among students [58]. As students welcome innovative curricula and approaches [59], new frameworks for teaching and learning, including the use of digital technology, should be applied to PE. Flipped learning is one of these new learning frameworks.

### 1.2. Flipped Learning

Flipped learning (FL) approaches facilitate a more student-centered and learning-focused view, rethinking the traditional way of conceiving and teaching: "The flipped approach inverts the traditional classroom model by introducing course concepts before class, allowing educators to use class time to guide each student through active, practical, innovative applications of the course principles" [60]. FL describes an inversion of where learning activities take place [61], promoting active learning strategies and student motivation [62]. According to Yough et al. [63], SDT provides an ideal frame for investigating the motivational implications of FL, where FL could very well function as part of autonomy supportive classrooms, promoting students' internalization process and internal

motivation. Autonomy supportive intervention programs (ASIPs) basically rely on noncontrolling language, providing explanatory rationales, and accepting and acknowledging negative affect [64,65]. When teachers become more autonomy supportive, students show gains in autonomous motivation, engagement, well-being, conceptual learning, and academic achievement [66]. This study does not include a fully developed ASIP, however, FL includes the introduction of digital technologies in terms of video introductions made available before class which aim to provide an explanatory rationale for the PE class.

The concept of FL in PE includes obtaining more time for practical activity and arranging for more physical and cognitive learning by the students in preparing prior to class. This preparation is preferably a video specific to the upcoming class and includes both practical information about the activities and theoretical knowledge underpinning the class topic/aim [67]. Very little research has been undertaken into the FL approaches [68] included in PE [69]. Casey et al. [70] argue that there is a lack of research on how digital technologies are used and how they affect motivation and learning in PE. However, there are studies suggesting that FL has a positive impact on student motivation in secondary school PE [71], especially among girls [72,73], and that both cognitive learning and perceived value of the subject are positively affected when a FL framework is applied in PE [67]. In a Chinese study of teaching basketball in PE, Chiang et al. [74] concluded that female students benefit more from flipped learning strategies compared to boys. The authors suggested that the observed gender differences might be explained by female students taking better advantage of the possibility to watch and repeat practice.

Further, in secondary school FL, approaches are used to promote individualization in learning orienteering skills [75] and to help learn rules in new games [76], with positive outcomes. A study among Spanish PE students in their last years of primary school found a FL approach, compared to a traditional approach, to benefit students in their class with content acquisition and retention [77]. Student learning in PE, in general terms, has in several studies been demonstrated to be positively affected as more time is allocated to practical activities when comparing FL classes to traditionally conducted ones [69,78–81]. In university PE, Hinojo-Lucena et al. [82] have demonstrated that a FL approach improves academic performance and positively affects motivation. While some negative aspects of FL are pointed out, like the extra work-load that some students perceive [83,84], the reported challenges are far fewer than the reported advantages [84], and a recent review of FL in K-12 education concludes that FL promotes active learning, providing a neutral or positive impact on student achievement [85]. These findings could suggest that the FL approach is beneficial across a range of school contexts and ages, and regarding several desired outcomes in PE.

Considering the limitations of previous research and the presented rationale, the purpose of the present study was to examine if and how the introduction of a flipped learning framework in Norwegian lower and upper secondary school PE could affect student situational motivation and health-related fitness knowledge (HRFK).

## 2. Materials and Methods

### 2.1. Participants

Norwegian students ( $N = 206$ , 56.6% of 364 invited) from six different secondary and upper secondary schools were included in this research project over a period of three weeks, during spring 2016. Self-reported information on sex, date of birth and name were obtained from the questionnaires to describe the sample. The girls ( $n = 97$ ) had an average age of 15.34 years ( $SD = 1.35$ ) and the boys ( $n = 109$ ), 15.02 years ( $SD = 1.18$ ). The participants were from four different levels in the Norwegian school system: the three years of secondary school and the first year of upper secondary school; Year 8 ( $n = 71$ ), Year 9 ( $n = 63$ ), Year 10 ( $n = 7$ ), Year 11 ( $n = 65$ ). The students' marks (girls: 4.49 and boys: 4.54) in the same semester also reflected the national average for 10th grade (girls: 4.5 and boys: 4.6) [86]. The schools involved represented both rural and central communities, with a normal distribution of

immigration and social statuses. The participants were divided into two groups: an intervention group (the flipped learning group, FL;  $n = 85$ , 42.4% girls) and a control group (the non-flipped learning group, NFL;  $n = 121$ , 50.5% girls). The Norwegian Centre for Research Data (NSD) gave their consent to conducting the present project (Project #47604), and the researchers followed the ethical guidelines and recommendations of The National Committee for Research Ethics in the Social Sciences and the Humanities [NESH] [87], including obtaining written consent from all participants above the age of 15 years, and from the parents of those students below the age of 15 years.

## 2.2. The Intervention

The intervention took place in the spring of 2016 and lasted over a period of three weeks. Three learning resources regarding endurance, strength and coordination were applied to the PE classes. Each resource consisted of a video that was assigned for viewing as homework before class, one in-class lesson plan the PE teachers performed, and a teacher's guide. The participants were divided into two groups: an intervention group (the flipped learning group, FL) and a control group (the non-flipped learning group, NFL). The FL group had access to the assigned homework before class, which comprised an online video. The videos were published online and lasted about 12 minutes, a timeframe within the suggested length for educational videos [88,89]. Each video gave an age-appropriate presentation of the upcoming PE class topic. For example, when endurance was the weekly topic, the video explained endurance by arguing why endurance improves health, what happens in the body when endurance is gained, and how to raise endurance. At the end of the video, a summary of the upcoming class content was given. As suggested by Geri et al. [90], Long et al. [89], and Frydenberg [91], short quizzes embedded in the videos were used to enhance the students' motivation to continue watching and to develop a deeper understanding of the content. The PE lessons were strongly linked to the video content and consisted of play-like activities, focusing on one of the three topics in the intervention. To illustrate what the transition to play-like activities would be, one example from the intervention was students performing different variations of 'tags' instead of a more traditional interval routine. The content of in-class activities was alike for the FL and NFL groups. This choice was taken deliberately by the researchers for two reasons. First, the content of PE traditionally has been focused on ball games and fitness training, something affirmed by Moen et al. [15], and does not fit all students well. Introducing more play-like activities for all students was meant to ensure a better fit for all participating students. Second, the transformation of in-class activity for both groups would ensure that the preparational phase of homework through videos, rarely observed in PE [92], only applied to the FL group and constituted FL in PE. To assure that the implementation was effectuated with fidelity, all participating teachers conducted classes both among the intervention and the control group. Further, the activities were grounded in a student-centered approach with an emphasis on cooperative learning, as this approach is shown to produce high levels of student engagement and empowerment so that students become central to the learning process, thus facilitating learning in all three of the psychomotor, cognitive and affective learning domains [93].

The teacher's guide explained thoroughly the intervention timeline, points of measurements and how to conduct the in-class activities. In addition, on the teacher's guide for the FL group, there was provided information on how to make sure that the students had access to the homework. All video and class content were based on relevant aims in the Norwegian national curriculum for secondary school physical education [1].

## 2.3. Measures

### 2.3.1. Motivation

Students' self-determined motivation for participation in PE was measured using the Situational Motivational Scale (SIMS) [94] with the initial question: "Why do you participate in PE?". The SIMS is designed to measure intrinsic motivation (IM), identified regulation (IR), external regulation (ER), and

amotivation (AM). There are two versions of the SIMS where these four constructs are built from 16 or 14 items. Two items from the 16-item version are omitted in the 14-item version, and the 14-item SIMS has been demonstrated to be a more superior fit than the 16-item SIMS in producing scores with acceptable reliability and validity in the educational and PE contexts [95–97], and have since been used in the PE context in several different countries [98,99]. The Norwegian version has been previously used in various studies [18,42] and later demonstrated to be both a reliable and valid instrument for measuring situational motivation in PE, echoing the original version also in the superiority of the 14-item version [96].

### 2.3.2. Health-Related Fitness Knowledge (HRFK)

HRFK was, in the present study, assessed by a multiple-choice questionnaire of the three topics of endurance, strength and coordination. Sample questions included “Why do you gain strength when training?” and “What does endurance mean?”, with one or more options indicating the right answer(s). The twenty questions emerged from two curriculum aims for the 10th grade: “practice and explain the basic principles of exercise and training” and “elaborate on the relationship between different physical activities, lifestyles and health” [1]. As students from the initial grade in upper secondary school were also included in the study, the questions were checked to align with the curriculum aims for PE in Year 11 on the topic of exercise, training and health. A pilot examination of the fitness knowledge questionnaire was conducted, resulting in some small adjustments to ensure that the questions were understood and that the levels of difficulty were appropriate for the given ages.

The students’ PE teachers handed out and collected the self-reporting questionnaires. This was done as instructed by the research leader at the start of the PE classes, both at the first day of the intervention (T1) and again on the last day of the intervention (T2).

### 2.4. Data Reduction and Analysis

The responses to the items on the SIMS were entered in SPSS and reduced by the constructs IM, IR, EM, and AM. The HRFK tests were scored as suggested on multiple choice tests, where more than one answer may be correct [100], and the three constructs of endurance, strength and coordination were computed from the twenty questions. The three constructs combined would represent the students’ HRFK. Before conducting the statistical tests, the data were cleaned and screened for out-of-range values, outliers, and sample distribution normality [101]. The formal normality tests showed values of skewness and kurtosis within normal range ( $< |0.62|$ ). Normal range is suggested to be  $< |2|$  [102]. Considering this, the data were regarded fit for conducting statistical tests for comparing means. Mixed factorial ANOVA, with an alpha level of .05, was used to determine whether male and female student motivation and knowledge had changed over time, and to what extent the introduction of FL would impact student motivation and HRFK. Separate ANOVA tests were run for each of the five dependent variables. Effect size was calculated using partial eta squared ( $\eta^2$ ), with benchmarks of 0.0099 for small, 0.0588 for medium, and 0.1379 for large [103]. The Pearson correlational coefficients were computed to discover possible correlations between any types of motivation and HRFK.

## 3. Results

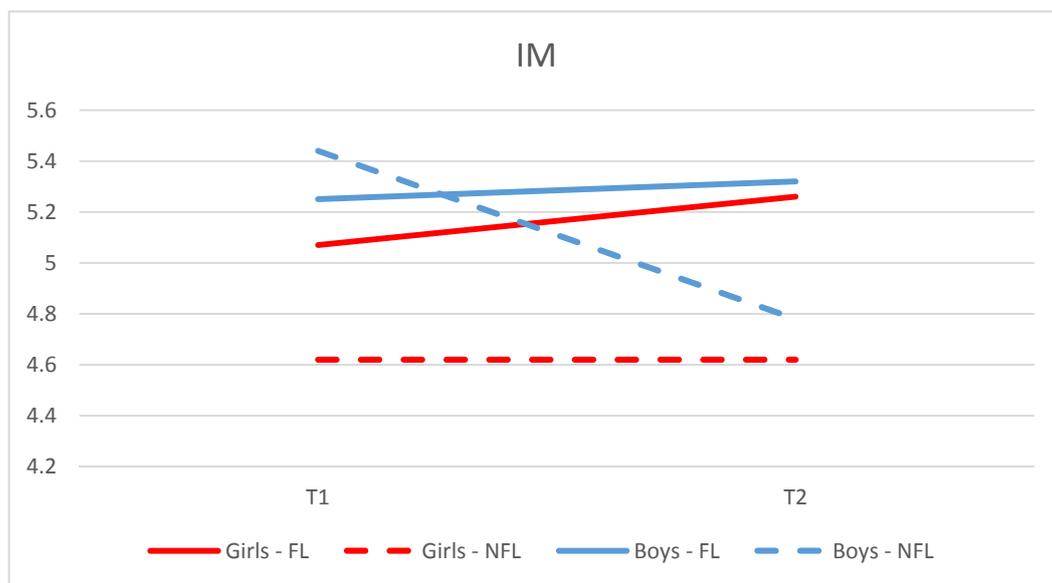
First presented are descriptive statistics of each variable of the SIMS and HRFK by gender, type of group and time of measurement (Table 1). Further, selected results of the mixed factorial ANOVA are presented as figures and text.

For IM, the ANOVA showed no main effect from time (see Figure 1):  $F(1, 202) = 1.43, p > .05$ . However, the interaction effects of time by instruction type and time by gender were statistically significant:  $F(1, 202) = 7.60, p < .01, \text{partial } \eta^2 = .036$ ,  $F(1, 202) = 5.56, p < .05, \text{partial } \eta^2 = .027$ , respectively.

**Table 1.** Mean and SD for each variable of the situational motivational scale (SIMS) and health-related knowledge (HRFK) in the intervention and control group by gender at T1 and T2.

	T1						T2					
	FL		NFL		TOTAL		FL		NFL		TOTAL	
	Girls n = 36	Boys n = 49	Girls n = 61	Boys n = 60	Girls n=97	Boys n=109	Girls n = 36	Boys n = 49	Girls n = 61	Boys n = 60	Girls N = 97	Boys N = 109
IM	5.07 (1.37)	5.25 (1.13)	4.62 (1.51)	5.44 (1.41)	4.79 (1.47)	5.35 (1.29)	5.26 (1.44)	5.32 (1.27)	4.62 (1.58)	4.78 (1.69)	4.86 (1.55)	5.02 <sup>b,c</sup> (1.54)
IR	5.67 (1.13)	5.52 (1.03)	5.16 (1.35)	5.47 (1.48)	5.35 (1.29)	5.49 (1.29)	5.60 (1.30)	5.56 (1.13)	4.98 (1.32)	5.11 (1.27)	5.21 (1.34)	5.31 (1.23)
ER	5.53 (1.21)	4.81 (1.62)	5.19 (1.62)	4.37 (1.55)	5.31 (1.48)	4.57 (1.59)	5.32 (1.50)	4.90 (1.40)	5.11 (1.57)	4.53 (1.59)	5.19 (1.54)	4.69 (1.51)
AM	2.26 (1.12)	2.47 (1.06)	2.39 (1.17)	2.07 (1.22)	2.34 (1.14)	2.25 (1.17)	1.94 (1.02)	2.57 (1.19)	2.35 (1.13)	2.36 (1.25)	2.19 (1.10)	2.45 <sup>c</sup> (1.22)
HRFK	53.17 (6.91)	51.67 (5.42)	54.25 (5.96)	52.67 (6.22)	53.85 (6.32)	52.22 (5.87)	55.67 (7.13)	56.35 (6.77)	54.90 (6.25)	55.52 (6.29)	55.58 (6.56)	55.55 <sup>a,b,c</sup> (6.52)

Note: FL = flipped learning group/intervention group; NFL = non-flipped learning group/control group; IM = intrinsic motivation; IR = identified regulation; ER = external regulation; AM = amotivation; HRFK = health-related fitness knowledge; <sup>a</sup> = sig. main effect of time; <sup>b</sup> = sig. interaction effect of time and instruction group; <sup>c</sup> = sig. interaction effect of time and gender.



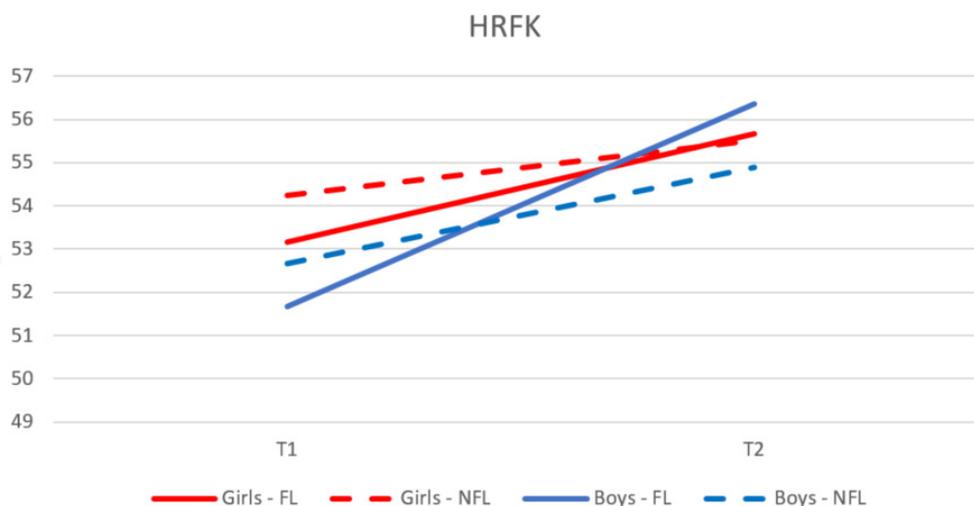
**Figure 1.** Intrinsic motivation (IM) for boys and girls in the FL and NFL groups over measurement times.

Due to interaction effects, simple effects for gender and instruction type were calculated. There was an effect for boys who showed a decline in IM from T1 (M = 5.35) to T2 (M = 5.02):  $F(1, 202) = 6.92$ ,  $p < .01$ , partial  $\eta^2 = .033$ . For girls, IM was stable from T1 (M = 4.79) to T2 (M = 4.86):  $F(1, 202) = .62$ ,  $p > .05$ , partial  $\eta^2 = .003$ . In addition, boys scored higher on IM compared to girls at T1:  $F(1, 202) = 6.49$ ,  $p < .05$ , partial  $\eta^2 = .031$ . There were no gender differences on IM at T2:  $F(1, 202) = .23$ ,  $p > .05$ , partial  $\eta^2 = .001$ . The simple effect for instruction group showed a decline in IM for the NFL group from T1 (M = 5.03) to T2 (M = 4.70):  $F(1, 202) = 9.59$ ,  $p < .01$ , partial  $\eta^2 = .045$ . The FL group had stable IM from T1 (M = 5.16) to T2 (M = 5.29):  $F(1, 202) = 1.03$ ,  $p > .05$ , partial  $\eta^2 = .005$ . At T1, there was no difference between the FL and NFL group:  $F(1, 202) = .44$ ,  $p > .05$ , partial  $\eta^2 = .002$ . At T2, the FL group scored higher on IM compared to the NFL group:  $F(1, 202) = 7.37$ ,  $p < .01$ , partial  $\eta^2 = .035$ .

There were no main or interaction effects concerning IR or ER. Simple effects were still calculated in order to check for gender and group differences at T1, showing that girls (M = 5.31) scored higher on ER compared to boys (M = 2.25):  $F(1, 202) = 12.39$ ,  $p < .01$ , partial  $\eta^2 = .058$ . There was, however, a time by gender interaction effect on AM:  $F(1, 202) = 6.56$ ,  $p < .05$ , partial  $\eta^2 = .031$ . Calculating simple effects showed a significant effect for male students, where they score higher on T2 (M = 2.45)

compared to T1 ( $M = 2.25$ ):  $F(1, 202) = 3.85$ ,  $p < .05$ ,  $\text{partial } \eta^2 = .019$ . The effect was not significant on female students:  $F(1, 202) = 2.80$ ,  $p > .05$ ,  $\text{partial } \eta^2 = .014$ .

There was a main effect of time on HRFK (see Figure 2):  $F(1, 202) = 55.48$ ,  $p < .01$ ,  $\text{partial } \eta^2 = .215$ . There was also a significant interaction effect of instruction group and gender on HRFK:  $F(1, 202) = 6.51$ ,  $p < .05$ ,  $\text{partial } \eta^2 = .031$  and  $F(1,202) = 4.76$ ,  $p < .05$ ,  $\text{partial } \eta^2 = .023$ , respectively.



**Figure 2.** Health-related fitness knowledge (HRFK) for boys and girls in the FL and NFL group over measurement times.

Simple effects for gender showed that girls increase their HRFK from T1 ( $M = 53.85$ ) to T2 ( $M = 55.58$ ):  $F(1, 202) = 12.76$ ,  $p < .01$ ,  $\text{partial } \eta^2 = .059$ . Boys also increased their HRFK from T1 ( $M = 52.22$ ) to T2 ( $M = 55.55$ ):  $F(1, 202) = 50.80$ ,  $p < .01$ ,  $\text{partial } \eta^2 = .200$ . Simple effects for instruction groups also showed significant increase in HRFK with the FL group having the largest increase from T1 ( $M = 52.42$ ) to T2 ( $M = 56.01$ ):  $F(1, 202) = 42.16$ ,  $p < .01$ ,  $\text{partial } \eta^2 = .173$ . Whereas the NFL group had a smaller increase from T1 ( $M = 53.46$ ) to T2 ( $M = 55.21$ ):  $F(1, 202) = 14.73$ ,  $p < .01$ ,  $\text{partial } \eta^2 = .068$ .

#### 4. Discussion

When implementing changes from a traditional sport-oriented PE towards a more varied and play-like PE, the main findings in this study show negative motivational changes for male students unless the activity changes are placed within an explanatory rationale through FL.

##### 4.1. Motivation

Previous research involving SIMS in the Norwegian context has shown that boys score higher on IM compared to girls, and that girls score higher on ER compared to boys [18]. This was also the case in our sample at T1, showing a point of departure in which boys are more autonomously motivated, with girls displaying a higher level of controlled motivation towards participation in PE. Looking at previous studies, there is reason to expect decreasing levels of autonomous motivation during the school years for both girls and boys [47,48]. However, results in the present study show that IM decreased for boys, whereas IM for girls remained stable from T1 to T2. These results need to be interpreted together with results showing that IM decreased for the NFL group, but not for the FL group. Figure 1 illustrates both mentioned observations and shows that the IM of boys in the NFL group decreases from T1 to T2. The slight increase in mean IM for boys and girls in the FL group is not significant and therefore, appears stable, along with the IM of girls in the NFL group. Hinojo Lucena et al. [71] found FL to increase the sense of autonomy among both primary and secondary PE students. One must take into account that the Spanish and Norwegian PE context might differ and the fact that this study did not test for differences across gender, so a direct comparison cannot be done.

Nevertheless, this study supports our findings in the positive effects FL might have upon student motivation in PE.

One important question is why boys in the NFL group experience a decrease in their IM. Part of the answer can be found in the activity change from traditional PE to a more play-like PE. The value system of traditional PE coincides with the value system of organized youth sport, emphasizing a discourse of competition, and resulting in a sport-oriented PE [18]. Studies in Norway and several other countries have shown that students who participate in organized sport outside school hours dominate and receive better grades in PE, particularly in the case of boys [16–23]. The shift from a traditional, sport-oriented PE could very well be expected to have more negative consequences for boys since they prefer and dominate traditional PE. Thus, the activity change could also explain the small (but significant) increase in AM for the boys.

This explanation is supported by the stable IM for girls in the NFL group. Girls participate, to a lesser extent, in organized sport and therefore, do not adapt equally well to traditional PE compared to boys [18], and the motivation for participation in PE is expected to drop, especially among girls [15,45]. We therefore argue that the activity change towards play-like activities in itself is more beneficial for girls' IM.

We then turn our attention to the combination of activity change and FL intervention. Since the IM of boys in the FL group is stable and the IM of boys in the NFL group declines, the FL intervention appears to decelerate the process of decreasing IM in boys when encountering activity changes. We interpret these results to show that providing context and meaning to activity changes in PE, in an autonomy supportive way, is of crucial importance. Chiang et al. [74] found gender differences with FL to be more beneficial for female students and suggest that female students take better advantage of the opportunity to watch and repeat video instructions. In contrast, the findings in the present study indicate relatively higher benefit from FL for boys. A plausible explanation for the contrasting findings is that the activity change from sport-like activities, in which boys are believed to be more dominant, increase the importance of providing context through FL. This is not to say that FL is not important for girls. However, the results show no differences between girls in the FL and NFL group, suggesting that in this particular study, it might be difficult to separate the impact of activity change and FL on the IM of girls.

#### 4.2. Health-Related Fitness Knowledge

In an effort to answer the call for more studies on learning outcomes [26], and more specifically cognitive knowledge learning [31,32], we included HRFK in the present study. The main effect of time on HRFK shows that students have a positive learning curve during the intervention period, independent of instruction group and gender. These results are in accordance with Zhu et al. [34], who found that middle school students' HRFK was low, but grew linearly throughout middle school. In the same study, Zhu et al. [34] found gender differences, with girls displaying a higher growth rate compared to boys, when implementing a curriculum tailored to enhance HRFK. Contradictory to these findings, the present study demonstrates that boys developed a higher level of HRFK compared to girls. Furthermore, these results need to be interpreted alongside our findings of the FL group scoring higher on HRFK compared to the NFL group at T2. Clearly, the FL group learned more in terms of HRFK during the intervention period. We argue that introducing FL with emphasis on HRFK instead of the traditional PE curriculum could result in a more meaningful frame of knowledge and understanding in terms of why PE activities are beneficial. In this way, FL enhances cognitive learning by providing explanatory rationales and in functioning as an autonomy supportive classroom, promoting students' internalization process [63]. Our findings also find support in the study of Villalon et al. [77] concluding with a positive impact on PE content acquisition and retention when a FL approach was compared to a traditional approach.

One interesting question following these findings is to what extent it is beneficial to move cognitive knowledge learning to outside of the gymnastics hall, supporting that the vigorous context of PE could

shift the attention of students from cognitive learning towards physical participation [33]. Inverting where learning activities take place and providing students with the opportunity to engage with learning materials, at a time and place that suits them, are important aspects of FL and appear to translate into increased HRFK.

Another interesting question that arises is whether there is a connection between changes in motivation and changes in HRFK, for example, whether students who become more highly IM also score higher on HRFK. We have run the appropriate correlational analysis and have found no significant correlations between any types of motivation and HRFK. This is in line with research from Sun and Chen [55], who found no relationship between motivation and knowledge learning, and at odds with research that has found a relationship between cognitive knowledge and autonomous motivation [56], and between HRFK and controlled motivation [104]. Sun and Chen [55] explain the lack of connection between motivation and knowledge learning in traditional PE in terms of it being centered on “happy, busy, good”, which might be motivating, but not lead to learning achievement. The present study is not a traditional sport-oriented PE program, but still we found no connection between motivation and HRFK, indicating that traditional PE in itself is an insufficient explanation. Clearly, the relationship between cognitive learning and motivation in PE is in need of more research.

However, the fact that students achieve a higher level of HRFK, without necessarily being highly motivated for learning, is obviously a good thing, since one important goal of the curriculum is to provide students with knowledge [1]. HRFK covers the knowledge necessary to improve and maintain health-enhancing levels of physical fitness and PA, and one could argue for the expectation of a positive relationship between HRFK and PA [34]. If this were the case, it would be beneficial to increase HRFK in order to achieve the goal of life-long participation in PA [1], and achieve some of the documented health benefits following PA [7]. However, findings in previous studies are not in agreement about the relationship between HRFK and PA, with some finding a positive relationship [105], and others finding no significant relationship [104]. It, therefore, seems unclear what the practical implications of increasing HRFK are [106].

## 5. Limitations

The short intervention period and lack of follow-up measures of motivation and HRFK is an obvious limitation in the present study. Even though previous training interventions have also found changes in autonomous motivation between baseline and four weeks [53], it would have been very interesting to investigate the longevity of the FL intervention with a follow-up at a later time (e.g., 1–2 months). Changes in boys' AM was not expected since others claim that changes in external motivation take a somewhat longer time, with the earliest changes detected six to eight weeks after the baseline [54]. Since the escalation in AM is exclusive to boys, we have argued that it is a result of the activity change from sport-oriented PE to more play-like PE. Since the design of the present study lacks a control group embedded in traditional, sport-oriented PE, we cannot claim to have isolated the possible impact of the activity change. We, therefore, suggest further research in this area.

## 6. Conclusions

As the motivation for participating in PE is demonstrated to decline as young adults go through secondary school, research must put light on this issue, and possibly suggest proper measures to halt this decline. One such measure, central in the new PE curriculum in Norway [107], is implementing an activity change to establish a more play-like PE. The present study demonstrates that girls benefit from such an activity change, but that the IM of boys is susceptible to negative development when experiencing a more play-like PE. However, when a FL framework was applied, the fall in IM was significantly halted compared to the NFL group, emphasizing the importance of providing context and meaning to activity changes in PE, in an autonomy supportive way. Among both girls and boys, the application of a FL framework caused more cognitive knowledge learning, resulting in higher levels of HRFK compared to the NFL group. The current research provided valuable insights into

Norwegian students' motivation for PE and that cognitive knowledge learning can be affected when integrating the use of ICT in PE. The findings of present study would be valuable for policymakers and stakeholders looking to promote the integration of ICT into PE as part of enhancing the outcomes of PE for all students. We recognize the limitations of the present study but also recognize that our findings might be relevant to other educational systems abroad. Readers of this paper should consider how the current findings could be relevant for their local context.

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