education sciences

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Flipped Classroom: A Good Way for Lower Secondary Physical Education Students to Learn Volleyball

Alberto Ferriz-Valero [1,2,3], Ove Østerlie [2,3,*], Salvador García-Martínez [1,2,3] and Salvador Baena-Morales [1]

[1] Department of General and Specifics Didactics, University of Alicante, 03690 San Vicente del Raspeig, Spain; alberto.ferriz@ua.es (A.F.-V.); salvador.garcia@ua.es (S.G.-M.); salvador.baena@ua.es (S.B.-M.)
[2] EDUCAPHYS Research Group, Department of General and Specifics Didactics, University of Alicante, 03690 San Vicente del Raspeig, Spain
[3] Research Group DiTePES: Digital Technology in Physical Education and Sports, Department of Teacher Education, Faculty of Social and Educational Science, Norwegian University of Science and Technology, 7491 Trondheim, Norway
* Correspondence: ove.osterlie@ntnu.no

Abstract: The ubiquity of digital technology in society and school demands that teachers and students explore various pedagogical approaches to make use of those technologies in a fruitful way in order to enhance students' educational outcomes. One approach emerging in the field of physical education (PE) is the pedagogical approach called flipped classroom (FC). The first purpose of this study was to assess the effects of the application of an FC approach on 284 Spanish secondary PE students regarding learning of the conceptual content of the activity itself, in this case volleyball. The second purpose was to assess how this intervention affected their motivation from an SDT perspective. Through a quantitative approach, positive results were found regarding the positive development of autonomous motivation and cognitive learning among students following an FC approach. These results were compared to a control group following a traditional approach to PE, highlighting the relevance of the methodology applied. The findings of the present study would be valuable for policymakers and stakeholders looking to promote the integration of digital technology into PE as part of enhancing the outcomes of PE for all students and thus contributing to quality and sustainable education.

Keywords: educational innovation; flipped learning; blended learning; active methodologies; motivation; psychosocial factors; academic performance; Edpuzzle; sport learning; quality education

Citation: Ferriz-Valero, A.; Østerlie, O.; García-Martínez, S.; Baena-Morales, S. Flipped Classroom: A Good Way for Lower Secondary Physical Education Students to Learn Volleyball. *Educ. Sci.* **2022**, *12*, 26. https://doi.org/10.3390/educsci12010026

Academic Editors: Yen-Ting Lin and Yi-Chun Lin

Received: 25 October 2021
Accepted: 30 December 2021
Published: 4 January 2022

1. Introduction

The educational process is continually adapting to the changes that occur in society, which rapidly evolve in the development of new information and communication technologies (ICTs). These advances in ICTs enable the development of new instruments, such as digital blackboard, tablets, smartphone applications, etc., that can produce more effective results in the teaching–learning process of students [1]. The use of these technological resources provides immediacy, interactivity, flexibility and adaptability to the circumstances in which the process is conducted [2]. ICTs are often used to replace traditional educational methods and approaches (e.g., the use of digital boards instead of traditional boards). Their employment can change the process followed by students in their learning, since they can interact in real time with the digital board or with your tablet, while they advance in learning and improve their attitude and predisposition, including their motivation and interest [3].

This trend towards the promotion of the use of ICTs is, therefore, generating the development of new educational strategies at different stages of the education system. One of them is the well-known approach of the Flipped Classroom (FC [4]). The origin of the FC approach dates to 2004, when Professors Jon Bergmann and Aaron Sams, Woodland Park

High School Chemistry teachers, began to design their classes in a digital format, using explanatory videos as reinforcement activity for students who needed it, thus responding to the worrying absenteeism they had in their classes. They realized that in addition to contributing effectively to the learning of these students, they had more time to respond to the educational needs of each student [4].

The FC is presented as an active methodology compared to traditional teaching methods, transforming the conventional form linked exclusively to classroom mastery learning, into an effective way of transmitting content: self-directed learning followed by reinforcement and practice. In fact, Ojalvo and Doyne [5] described the FC as a pedagogical approach that aims to alter the traditional teaching approach. These authors claimed that by delivering the teaching material outside classrooms, students could use the time of the class session to absorb that material through problem solving and developing specific skills. It is argued that if this preparational material is in video format, it is preferred by the student rather than textbook material [6]. The FC approach does not subscribe to the idea of replacing teachers with computers, mobile devices or videos, but rather that students commit themselves to their own learning in a combined process with the teacher [7]. The use of the FC approach also promotes self-learning, self-employment and concern for time management in students [8]. Furthermore, Iborra Urios et al. [8] claim that this increases the effectiveness of the contact session, as a deeper understanding of the contents pursued in the teaching–learning process is achieved.

For this reason, professionals in the field of physical education (PE), at all educational stages, are very interested in the evolution and development of this new approach in order to increase their students' motor engagement time in classes [9], and to facilitate more time for practice in order to combat the problem of sedentarism. As is well known, PE is an eminently practical subject, although, like all subjects, it has a fundamental theoretical basis that unifies the competences of knowing: knowing how to do and knowing how to be [10]. Considering that many students do not perform physical activity during the week, except in PE classes, replacing time spent on transmitting some conceptual content by physical activity sounds very appealing from the educational and child health point of view [11].

Many studies have already investigated the effects of students following an application of the FC approach in various educational areas and levels [12–23]. However, very few studies have focused their research on benefits within the PE area at different educational levels [24].

In primary education, Felgueras and Delgado [25] observed a higher performance of handball skills in a group that received FC classes. Botella et al. [26] claimed that, after applying the FC approach in PE, intrinsic motivation increased significantly and amotivation values decreased in FC groups. These same authors claimed the FC approach allows the use of more time in PE classes, and consequently it is perceived as more fun for the students. Further, Marqués-Molías et al. [27] showed significant differences in Korfball performance, and, more specifically, in the rules and application of game strategy during game play, where the FC students scored higher. Finally, in both primary and secondary school PE students, Hinojo et al. [28] demonstrated that the FC group obtained better evaluations in the academic indicators, highlighting the motivation, autonomy and interactions between the different agents.

In secondary school as well, Østerlie and Kjelaas [6] and Østerlie and Mehus [29] claimed a positive perception of FC in PE, where FC seems to facilitate deep learning in PE, facilitated by motivation, knowledge and the nature of the approach. These findings are supported in other studies, concluding that the FC approach positively affects student motivation in secondary PE [30]. However, Campos-Gutiérrez et al. [9] and Gómez-García et al. [31] did not observe any differences in motivation but only in motor practice time when applied in primary schools.

Similar results have been found at the university stage. Cuenca-Ruano et al. [32] concluded that the FC group presented greater values in the approach/mastery, teaching, and learning variables. When using the FC approach, teacher students have higher levels of

motivation and flow status than those who teach using a traditional methodology. Hinojo et al. [33] showed how the FC approach positively influenced academic performance and correlational motivation and support in PE teacher students. However, Ferriz-Valero et al. [34] found no differences between treatment groups in either academic performance or motivational values.

Finally, the discrepancies in findings have resulted in several calls for more research on how FC affects student motivation in PE [30,35]. In addition to being scarce in number, studies have very discreet samples and diverse designs, especially among secondary school students. For example, some studies evaluate motivation from a qualitative [6] or different approach to Self-Determination Theory (SDT) [29]. For this reason, the purpose of this study was to assess the effects of the application of an FC approach on secondary students regarding the acquisition of the conceptual content of the sport itself, in this case volleyball, and to assess how this intervention affects the motivational variables understood under the SDT perspective. Therefore, the following hypotheses are formulated:

Hypothesis 1 (H1). *The group of students experiencing FC would increase their learning compared to the control group.*

Hypothesis 2 (H2). *The group of students experiencing FC would increase their intrinsic motivation compared to the control group.*

Hypothesis 3 (H3). *The group of students experiencing FC would not change their most extrinsic motivation compared to the control group.*

Hypothesis 4 (H4). *The group of students experiencing FC would decrease their amotivation compared to the control group.*

2. Materials and Methods

The research was carried out within the context of physical education in lower secondary education. Data collection was carried out between October and December during two academic courses (2018–2019 and 2019–2020) in an educational public center in Alicante city (Spain). The present investigation is based on a natural experiment with a non-randomized controlled design with a pre and a post measure [36]. The design reflected the layouts in similar studies [9,26,29,32].

2.1. Sample

The sample included students of first and second grade of secondary school who had not repeated a year and who performed physical education without any limitation or injury. Initially, 374 secondary students participated (Table 1). After applying the exclusion criteria, a final sample of 284 students remained (160 boys: 56.3% and 124 girls: 43.7%). Sampling was carried out by non-probabilistic conglomerates, respecting the group configured by the educational center, and following criteria of compensation per ratio and sex.

Table 1. Descriptive data of the sample (*n*) regarding sex, grade and treatment.

Grade	Sex	Flipped Group (*n*)	Control Group (*n*)	Excluded (*n*)
First (12–13 years old)	Male	51	67	18
	Female	35	54	14
Second (13–14 years old)	Male	26	16	27
	Female	21	14	34
	Total	133	151	90

Exclusion criteria were: (1) not reaching 80% attendance at the intervention lessons; (2) not completing the questionnaires pre or post; (3) not watching the videos in Edpuzzle and belonging to the experimental group; and (4) being a member of a volleyball team in extracurricular activities. All the participants were informed about the study, and both the participants and the educational center approved their participation and agreed to the publishing of the results anonymously. The study was approved by the University of Alicante's research ethics committee (UA-2020-09-02). Regarding the third exclusion criterion, the educational center made the computer classroom available from 14:00 to 15:00 for students who did not have electronic devices with internet connection.

2.2. Instruments

2.2.1. Knowledge Test

The volleyball knowledge test (VKT) consists of 16 questions. The questions were created with four possible answers, with only one being valid, as agreed by the Department of Physical Education and elaborated to this research. These questions included content about technical aspects: overhead pass, forearm pass, serve and serve types (Appendix A). The dependent variable was calculated through the following Formula (1):

$$\text{VKT} = \text{Right questions} \cdot \frac{10}{16} \quad (1)$$

2.2.2. Motivation

The Questionnaire on Motivation in Physical Education Classes [37] includes 20 items investigating the following five factors (four questions per item): intrinsic motivation (e.g., ... because Physical Education is fun); identified regulation (e.g., ... because I can learn skills that I could use in other areas of my life); introjected regulation (e.g., ... because it is what I have to do to feel good); external regulation (e.g., ... because it is seen by the teacher and classmates); and amotivation (e.g., ... but I do not understand why we should have Physical Education). These items had a closed response option, following a Likert scale from 1 to 5, with 1 (= totally disagree) to 5 (= totally agree). After confirmatory factor analysis to check validity, an excellent fit of the data was obtained (CFI = 0.96; TLI = 0.95; GFI = 0.95; SRMR = 0.04; and RMSEA = 0.05). The scale showed adequate internal consistency ($\alpha > 0.70$) as well as good nomological validity.

2.3. Procedure

The total sample set was divided into two groups. The first experimental treatment group (FLIP) received Physical Education lessons with the support of the Flipped Classroom. The second treatment group or control group (CON) received the same content as the first group (FLIP) through a traditional methodology. This traditional methodology is the one usually used by the physical education teacher in the rest of the sessions. In short, the first group watched videos on the Edpuzzle platform before the sessions and the second group had notes with the same content of the videos: technical aspects such as overhead pass, forearm pass, serve and serve types.

On the first day of the physical education class, all students were asked to complete the motivation questionnaire [37] (Table 2). After completing it, all the students completed the VKT in order to evaluate their prior knowledge about volleyball before the intervention was carried out. The students did not receive feedback on the results in the pre-test. To conclude this session, the use and development of the digital platform Edpuzzle was explained to the FLIP group, and the control group received instructions on accessing the points throughout the development of the work teaching unit.

Table 2. Research design outline.

Lesson	Content	Time (min)	Group	Place
1	Motivation questionnaire (pre)	10	Both	Class
	VKT (pre)	10		
	Project explanation	25		
	Edpuzzle explanation	10	(Only FLIP)	
2	Overhead pass	50	Both	Volleyball courts
3	Forearm pass	50	Both	
4	Overhead and forearm pass	50	Both	
5	Hand down serve	50	Both	
6	Standing serve (tennis)	50	Both	
7	Play game (rotations)	50	Both	
8	Motivation questionnaire (post)	10	Both	Class
	VKT (post)	10		

VKT = Volleyball knowledge test.

In the rest of the sessions, for students who received the classes with an FC approach, a digital platform with free access to video display was used, namely Edpuzzle (https://edpuzzle.com/home, accessed on 1 January 2021), where four short videos (of approx. 3–4 min) were launched for students. The first of these was dedicated to the technical aspects of the overhead pass. The second was dedicated to the forearm pass, with the third and fourth dealing with different types of serve and their execution. These videos were available on the Edpuzzle platform for students belonging to the FLIP experimental group. These videos were available up to the time of the next class, where the contents concerned were worked through. Regarding the control group working through a traditional methodology, the teacher provided notes with the same content treated in the videos, so that the students had access to the same information as the experimental group.

Both groups received two sessions per week during the duration of the didactic unit (eight sessions). The last session was dedicated to conducting the motivation questionnaire and the final VKT (post-test).

2.4. Data Analyses

According to Faul et al. [38], the statistical power of the sample size was calculated using the free software G*Power (Ver. 3.1.9.6, University of Dusseldorf, Dusseldorf, Germany). The sample size, 133 participants in the FLIP group and 151 participants in the CON group, with an estimated medium effect size (0.5) and a significance of 95%, resulted in a power of 0.95. All continuous variables in the data set were subjected to a normality test (Kolmogorov–Smirnov). Each variable's descriptive statistics (mean and standard deviation) were calculated. The data were further subjected to a chi-square analysis and univariate statistical analysis for non-parametric samples, specifically the Mann–Whitney U test, to assess the differences between the treatment groups (FLIP vs. CON) on two occasions: pre and post intervention. The Wilcoxon test was applied to observe the intra-group differences (pre vs. post). The level of significance was established at $p < 0.05$ in all cases. In these non-parametric tests, the effect size was also calculated using Microsoft Excel software (Microsoft Corp., Redmond, WD, USA) [39]. This magnitude was regarded as small when values ranged between 0.1–0.3, medium between 0.3–0.5 and large if greater than 0.5 [40,41]. Data were analyzed with IBM SPSS (Version 24) and Microsoft Excel (Version 2016). The effect size (ES) was calculated by the partial eta-squared (η^2_p) in ANOVA 2 × 2.

3. Results

3.1. Baseline Differences

Before submitting the results in this section, it was reported that the values represented by the motivational variables assessed were calculated from the average of the items of the

questionnaire (e.g., intrinsic motivation value = item 1 + item 6 + item 11 + item 16), where the minimal result could be 1 and the maximal result 5 in each of the variables measured. A Mann–Whitney U Test (Table 3) revealed significant differences between groups at the baseline in the following variables: intrinsic motivation (Z = −2.621, $p = 0.009$, only females); introjected regulation (Z = 2.056, $p = 0.040$, only males) and external regulation (Z = −3.451, $p = 0.001$, only males). In all cases, effect sizes were considered small. As factorial ANOVAs 2 × 2 (Time × Treatment) was applied, the initial differences in these variables were considered. A chi-square analysis found no differences in the distribution by gender ($p = 0.620$).

Table 3. Comparing variables between FLIP and CON at pre-test using Mann–Whitney U test according to gender (Av ± SD).

Sex	Variables	Flipped Group	Control Group	Mann–Whitney U Test	Effect Size
Male $n_{flip} = 77$ $n_{con} = 83$	VKT	2.96 ± 1.80	3.60 ± 2.01	1.962	-
	Intrinsic M.	4.22 ± 0.68	4.19 ± 0.72	−0.138	-
	Identified R.	3.13 ± 0.89	3.04 ± 0.93	−0.547	-
	Introjected R.	1.25 ± 0.53	1.47 ± 0.73	2.056 *	0.162
	External R.	4.20 ± 0.76	3.75 ± 0.86	−3.451 ***	0.273
	Amotivation	2.72 ± 1.13	2.71 ± 1.05	−0.065	-
Female $n_{flip} = 56$ $n_{con} = 68$	VKT	3.16 ± 1.89	3.48 ± 2.00	0.670	-
	Intrinsic M.	3.73 ± 0.88	4.11 ± 0.63	2.621 **	0.235
	Identified R.	2.82 ± 0.83	2.77 ± 0.91	−0.275	-
	Introjected R.	1.28 ± 0.47	1.37 ± 0.62	0.496	-
	External R.	3.66 ± 0.93	3.59 ± 0.91	−0.378	-
	Amotivation	2.42 ± 1.09	2.52 ± 0.97	0.812	-
Total $N_{flip} = 133$ $N_{con} = 151$	VKT	3.04 ± 1.84	3.55 ± 2.00	1.938	-
	Intrinsic M.	4.01 ± 0.80	4.15 ± 0.68	1.330	-
	Identified R.	3.00 ± 0.88	2.92 ± 0.93	−0.633	-
	Introjected R.	1.26 ± 0.51	1.42 ± 0.68	1.882	-
	External R.	3.97 ± 0.87	3.68 ± 0.88	−2.899 **	0.172
	Amotivation	2.59 ± 1.12	2.63 ± 1.02	0.514	-

VKT = Volleyball knowledge test; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

3.2. Comparison between Groups Post-Intervention

The two treatment groups showed differences at the post-test in the VKT and intrinsic motivation in both males and females (Table 4). Firstly, after the intervention, the experimental group FLIP achieved higher performance in the VKT variable than the control group in both boys and girls. In addition, the Mann–Whitney U Test also revealed a significant difference in intrinsic motivation, being greater in the FLIP group. Most of the effect sizes are considered medium.

Table 4. Comparing variables between FLIP and CON at post-test using Mann–Whitney U test according to gender (Av ± SD).

Sex	Variables	Flipped Group	Control Group	Mann–Whitney U Test	Effect Size
Male $n_{flip} = 77$ $n_{con} = 83$	VKT	7.05 ± 1.63	5.77 ± 2.27	−3.551 ***	0.280
	Intrinsic M.	4.48 ± 0.49	3.82 ± 0.85	−5.218 ***	0.412
	Identified R.	2.88 ± 1.05	2.81 ± 1.05	−0.324	-
	Introjected R.	4.43 ± 0.58	4.22 ± 0.75	−1.727	-
	External R.	2.99 ± 1.05	2.97 ± 1.05	−0.110	-
	Amotivation	1.31 ± 0.57	1.52 ± 0.85	1.171	-

Table 4. *Cont.*

Sex	Variables	Flipped Group	Control Group	Mann–Whitney U Test	Effect Size
Female n_{flip} = 56 n_{con} = 68	VKT	7.19 ± 1.54	5.22 ± 2.11	−5.070 ***	0.455
	Intrinsic M.	4.30 ± 0.53	3.70 ± 0.81	−4.264 ***	0.382
	Identified R.	2.68 ± 1.07	2.61 ± 1.00	−0.345	-
	Introjected R.	4.06 ± 0.71	4.06 ± 0.76	−0.023	-
	External R.	2.78 ± 0.87	2.80 ± 0.92	0.161	-
	Amotivation	1.20 ± 0.43	1.38 ± 0.70	1.501	-
Total N_{flip} = 133 N_{con} = 151	VKT	7.11 ± 1.59	5.52 ± 2.21	−6.115 ***	0.362
	Intrinsic M.	4.40 ± 0.51	3.77 ± 0.83	−6.772 ***	0.401
	Identified R.	2.80 ± 1.06	2.72 ± 1.03	−0.541	-
	Introjected R.	4.28 ± 0.66	4.15 ± 0.76	−1.540	-
	External R.	2.90 ± 0.98	2.89 ± 1.00	−0.018	-
	Amotivation	1.26 ± 0.52	1.46 ± 0.78	1.796	-

VKT = Volleyball knowledge test; *** $p < 0.001$.

3.3. Comparison Intra-Groups (Pre vs. Post)

The experimental group showed significant differences in all variables except identified regulation in females (Table 5). All post-test values for pre-test increased except for identified regulation, external regulation and amotivation, which decreased. Most of the effect sizes were considered large.

Table 5. Comparing variables intra-group (pre vs. post) using Wilcoxon test according to gender in flip group (Av ± SD).

Sex	Variables	PRE	POST	Wilcoxon Test	Effect Size
Male n = 77	VKT	2.96 ± 1.80	7.05 ± 1.63	−7.643 ***	0.871
	Intrinsic M.	4.22 ± 0.68	4.48 ± 0.49	−2.957 **	0.336
	Identified R.	3.13 ± 0.89	2.88 ± 1.05	−2.021 *	0.230
	Introjected R.	1.25 ± 0.53	4.43 ± 0.58	−7.647 ***	0.871
	External R.	4.20 ± 0.76	2.99 ± 1.05	−6.770 ***	0.771
	Amotivation	2.72 ± 1.13	1.31 ± 0.57	−6.878 ***	0.783
Female n = 56	VKT	3.16 ± 1.89	7.19 ± 1.54	−6.519 ***	0.871
	Intrinsic M.	3.73 ± 0.88	4.30 ± 0.53	−5.051 ***	0.674
	Identified R.	2.82 ± 0.83	2.68 ± 1.07	−1.022	-
	Introjected R.	1.28 ± 0.47	4.06 ± 0.71	−6.519 ***	0.871
	External R.	3.66 ± 0.93	2.78 ± 0.87	−5.249 ***	0.701
	Amotivation	2.42 ± 1.09	1.20 ± 0.43	−5.628 ***	0.752
Total n = 133	VKT	3.04 ± 1.84	7.11 ± 1.59	10.024 ***	0.869
	Intrinsic M.	4.01 ± 0.80	4.40 ± 0.51	5.644 ***	0.489
	Identified R.	3.00 ± 0.88	2.80 ± 1.06	−2.227 *	0.193
	Introjected R.	1.26 ± 0.51	4.28 ± 0.66	10.026 ***	0.869
	External R.	3.97 ± 0.87	2.90 ± 0.98	−8.557 ***	0.741
	Amotivation	2.59 ± 1.12	1.26 ± 0.52	−8.871 ***	0.769

VKT = Volleyball knowledge test; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Conversely, the control group also showed significant differences in all variables except identified regulation in both males and females (Table 6). All post-test values for pre-test decreased except for VKT and introjected regulation, which increased. Most of the effect sizes were considered large.

Table 6. Comparing variables intra-group (pre vs. post) using Wilcoxon test according to gender in control group (Av ± SD).

Sex	Variables	PRE	POST	Wilcoxon Test	Effect Size
Male n = 83	VKT	3.60 ± 2.01	5.77 ± 2.27	7.151 ***	0.784
	Intrinsic M.	4.19 ± 0.72	3.82 ± 0.85	−3.796 ***	0.416
	Identified R.	3.04 ± 0.93	2.81 ± 1.05	−1.846	-
	Introjected R.	1.47 ± 0.73	4.22 ± 0.75	7.769 ***	0.852
	External R.	3.75 ± 0.86	2.97 ± 1.05	−5.527 ***	0.606
	Amotivation	2.71 ± 1.05	1.52 ± 0.85	−6.219 ***	0.682
Female n = 68	VKT	3.48 ± 2.00	5.22 ± 2.11	5.966 ***	0.723
	Intrinsic M.	4.11 ± 0.63	3.70 ± 0.81	−4.383 ***	0.531
	Identified R.	2.77 ± 0.91	2.61 ± 1.00	−0.800	-
	Introjected R.	1.37 ± 0.62	4.06 ± 0.76	7.088 ***	0.859
	External R.	3.59 ± 0.91	2.80 ± 0.92	−5.197 ***	0.630
	Amotivation	2.52 ± 0.97	1.38 ± 0.70	−5.916 ***	0.717
Total n = 151	VKT	3.55 ± 2.00	5.52 ± 2.21	9.355 ***	0.761
	Intrinsic M.	4.15 ± 0.68	3.77 ± 0.83	−5.768 ***	0.469
	Identified R.	2.92 ± 0.93	2.72 ± 1.03	−1.832	-
	Introjected R.	1.42 ± 0.68	4.15 ± 0.76	10.504 ***	0.854
	External R.	3.68 ± 0.88	2.89 ± 1.00	−7.576 ***	0.616
	Amotivation	2.63 ± 1.02	1.46 ± 0.78	−8.587 ***	0.698

VKT = Volleyball knowledge test; *** $p < 0.001$.

3.4. Hypothesis Testing

With regard to academic performance, an interaction effect (Time × Treatment) was found for the volleyball knowledge test. The FLIP group increased significantly more in this variable after the intervention compared to the control group, both in males (F(1) = 62.08, $p \leq 0.001$; $\eta^2_p = 0.282$) and females (F(1) = 49.94, $p \leq 0.001$; $\eta^2_p = 0.287$).

According to the motivation variables, an interaction effect (Time × Treatment) was found for intrinsic motivation in both males (F(1) = 25.11, $p \leq 0.001$; $\eta^2_p = 0.137$) and females (F(1) = 54.69, $p \leq 0.001$; $\eta^2_p = 0.310$), introjected regulation in only males (F(1) = 6.98, $p = 0.009$; $\eta^2_p = 0.042$) and external regulation in only males (F(1) = 6.38, $p = 0.013$; $\eta^2_p = 0.039$). That is, the FLIP group increased significantly more in all variables after the intervention compared to the control group, except for the variable external regulation, which decreased in the two treatment groups and more significantly in the FLIP group.

4. Discussion

The purpose of this study was to assess the effects of the application of an FC approach on secondary PE students regarding learning of the conceptual content of the activity itself, in this case volleyball, and to assess how this intervention affected their motivation. The main finding was that both student motivation and learning were positively affected by students participating in an FC approach.

Regarding learning or the academic performance, an interaction effect was found for the volleyball knowledge test (VKT). The FLIP group increased significantly more in this variable after the intervention compared to the control group, across gender. This result is in line with similar findings among secondary school PE students in Norway benefiting in their learning of health-related fitness knowledge (HRFK) when experiencing an FC approach [29]. The argumentation of Østerlie and Mehus [29] to explain their findings pointed to the FC approach forming the basis for more meaningful PE, where students found learning (cognitively) about the activity interesting. Hence, FC in PE seems to improve cognitive learning by supporting explanatory reasonings and in acting as an autonomous, encouraging environment, fostering students' incorporation process [42]. The fact that in the FC approach the student (cognitive) learning is moved outside the gymnastics hall, or wherever PE takes place, seems to enhance the desire for learning, as

students seem not to want to attend or focus on (cognitive) learning in PE arenas [6,29]. There are studies that suggest a positive relationship between the students' development of health-related fitness knowledge and PA behavior in PE [43,44], but others conclude that more research is needed to clarify the influence of students' health-related fitness knowledge on reflection, understanding, physical activity behavior and overall physical literacy levels [45].

Contrary to the observations in the present study, previous research on motivation in PE demonstrates that boys have higher autonomous motivation than girls [29,46,47]. In the present study, we found that girls and boys both benefited from the FC approach when compared to the control group, who experienced a decrease in the autonomous motivational variable intrinsic motivation. Regarding controlled motivation, we found girls and boys to be affected differently. The somewhat external motivation variable introjected regulation and the variable external regulation were only in males significantly different when compared to the control group. In other words, the FLIP group increased significantly more its values in introjected regulation than the control group and significantly decreased its external regulation values further. In total, the FC group increased significantly more in all variables after the intervention compared to the control group, except for the variable external regulation, which decreased in the two treatment groups, though more significantly in the FC group. Across gender, FC seems to lay the ground for students to positively develop their autonomous motivation. This finds support in other work looking into how FC affects student motivation in PE seen from an SDT perspective [29]. Among Spanish primary and secondary PE students, Hinojo et al. [28] found FC to enhance the sense of autonomy, resulting in the conclusion that FC is an effective teaching and learning approach in PE. On the other hand, scholars such as Chiang et al. [48] found girls to take better advantage of the FC approach, as they more likely used the opportunity to see instructional videos, online, outside school hours. Finally, one must interpret the findings in the present study with findings that both diverge and converge in their conclusions, such as the results from Ferriz-Valero et al. [34], Campos-Gutiérrez et al. [9] and Gómez-García et al. [31], who found FC to not affect student motivation and/or learning in PE. This variety in findings might be caused by the reality that FC in PE is still in its very infancy, both in practice and in research, and that most studies still evolve around fragmented parts of the subject PE and for shorter periods of time. The definition of what learning is in PE and how learning is understood, operationalized and measured might also cause divergent findings across studies.

Regarding a possible relationship between VKT and student motivation, this was a connection not investigated in the present study. From the results, it was observed that the development of knowledge, measured in a VKT, did not differ across gender, but the development of motivation in the same FC learning environment did so, at least in some motivational constructs. This might point to a not very strong relationship between motivation and knowledge development when FC is applied in PE. This assumption finds support in results in other studies, where there was no correlation between the development of HRFK and any motivational construct in secondary school PE where FC was the pedagogical approach [29]. This is in line with research from Sun and Chen [49], who did not find a relationship between motivation and knowledge learning. Nevertheless, there are PE research studies suggesting a positive relationship between cognitive knowledge and controlled or autonomous motivation, although not within an FC context [50,51]. Nevertheless, the finding that FC seems to promote an increase both in learning and motivation among PE students is positive, whether these variables correlate or not.

5. Conclusions

As information and communication technologies (ICTs) seem to penetrate all parts of society, it is important to innovate, develop and amend pedagogical approaches in all school subjects that benefit from these technologies. In PE, the approach called flipped classroom (FC) has gained recognition over the last decade. However, there is scarce

research looking into how this approach affects students in their learning in PE and their motivation towards PE. This study demonstrates that Spanish secondary students both benefited in their learning and in their autonomous motivation when learning volleyball in PE and attending classes where FC guided the learning process. There are both strengths and weaknesses in this study. One strength is the use of a highly established theoretical lens—SDT—to examine student motivation in the PE context as well as the use of validated instruments to measure the motivation in secondary students. A limitation might be that participants were all from the same school, making wider generalization less possible. The findings of the 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. Although the design of this study only considered one sport (volleyball), we consider that the results can be generalized to other sports as the design considered a control group. We encourage further examination of how FL affects student learning and motivation in PE, preferably across cultures and nations and from a longitudinal perspective.

Author Contributions: Conceptualization: A.F.-V. and O.Ø.; methodology: A.F.-V. and S.G.-M.; formal analysis: S.B.-M.; resources: O.Ø.; data curation: S.B.-M.; writing—original draft preparation: A.F.-V. and O.Ø.; writing—review and editing: S.G.-M. and S.B.-M.; supervision: A.F.-V.; project administration: A.F.-V. All authors have read and agreed to the published version of the manuscript.

Funding: This research was supported by Consejo Superior de Deportes (Spain) under Grant 20/UPB/21—Research Network for the Promotion of Equality and Physical Activity in Education (RIPIAFE).

Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the University of Alicante's research ethics committee (UA-2020-09-02).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The raw data supporting the conclusions of this article will be made available by the authors, without reservation.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

The Spanish Version of the Volleyball Knowledge Test (VKT).

Cuestionario de conocimientos conceptuales de voleibol para alumnado Educación Secundaria Obligatoria (1 y 2)

Nombre:.....

Curso:..... Grupo:..... Número de clase:.....

A continuación te proponemos que rellenes el siguiente cuestionario para comprobar los conocimientos que tienes sobre voleibol. Marca de las cuatro opciones sólo la que pienses que sea la correcta. No olvides rellenar tus datos personales.

1. Cuando se pasa la pelota mediante toque de dedos, el balón . . .

a. Se golpea con las palmas de las manos.
b. Se puede coger.
c. Se puede coger y botar.
d. Se golpea con los dedos de las manos.

2. Cuando se da un pase de antebrazos, el contacto se realiza . . .

a. Por encima de los hombros.
b. Con el pie.
c. Como tú quieras.
d. Con las dos manos.

3. ¿Qué golpe utilizarías si el balón te llega a la altura de la cadera?

a. Toque de antebrazos.
b. Toque de dedos.
c. Golpeo con una mano.
d. Es indiferente.

4. Cuando se toca de antebrazos, ¿Cómo deben estar las manos?

a. Separadas.
b. Abiertas.
c. Cogidas, con las manos entrelazadas.
d. Agarradas, una sobre otra.

5. ¿Qué golpe utilizarías si el balón te llega por encima de la cabeza?

a. Toque de antebrazos.
b. Toque de dedos.
c. Golpeo con una mano.
d. Es indiferente.

6. Cuando se pasa el balón mediante toque de dedos, el contacto se realiza . . .

a. Por encima de los hombros.
b. Lateral respecto al lugar de envío del pase.
c. Por debajo de los hombros.
d. Es indiferente.

7. Cuando se pasa de antebrazos, ¿cómo tienen que estar los codos?

a. Es indiferente.
b. Extendidos.
c. Flexionados.
d. Formando un ángulo de 90°.

8. Cuando se da un pase de dedos, ¿con qué nos ayudamos para impulsar el balón?

a. Con manos, brazos y piernas.
b. Solo con los brazos.
c. Solo con las manos.
d. Solo con las piernas.

9. En el saque de mano baja, antes del golpeo (señala la incorrecta):

a. El cuerpo tiene que estar orientado hacia el campo.
b. Se adelanta el pie contrario al brazo con el que se da al balón (los diestros adelantan el pie izquierdo y los zurdos el pie derecho).
c. El balón se sujeta con la mano contraria a la que lo golpea (igual que con los pies).
d. Todas son falsas

10. Durante el saque de mano baja:

a. Se golpea el balón en la parte posterior y por debajo.
b. La mano que tiene el balón lo suelta antes de golpearle. No se lanza hacia arriba el balón.
c. Coordinadamente se estiran las piernas. No se separan los pies del suelo en ningún momento.
d. Todas son verdaderas.

11. Después del saque de mano baja, se debe:

a. Cambiar el peso de la pierna de atrás con la de delantera.
b. Salir del campo de juego.
c. El brazo que golpea al balón se para en seco.
d. Hacer un gran grito.

12. Existen tres formas de hacer el saque de mano baja:

a. Cuchara, palma tensa y mano cerrada.
b. Cuchara, palma tensa y cucharón.
c. Palma tensa, palma rígida y mano abierta.
d. Todas son falsas.

13. El saque bajo también es conocido como:

a. Saque flow.
b. Saque rápido.
c. Saque de seguridad.
d. Saque bombeado.

14. Si estás jugando con tus amigos-as, es más común utilizar:

a. El saque de tenis o de seguridad.
b. El saque bajo o de seguridad.
c. El saque volteado o de seguridad.
d. Ninguna es correcta.

15. Identifica qué saque no existe en voleibol

a. Saque flotante.
b. Saque bajo.
c. Saque "topspin".
d. Saque medio.

16. La mayor diferencia entre los tipos de saques por encima de la cabeza son:

a. La posición del cuerpo del jugador.
b. Parte de la pelota donde se realiza el contacto.
c. El acompañamiento que se hace al balón.
d. Todas son correctas.

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