



JOURNAL  
OF BALTIC  
SCIENCE  
EDUCATION

ISSN 1648-3898 /Print/

ISSN 2538-7138 /Online/

**Abstract.** *The students' engagement was deemed significant to research due to the changing study structures from course-based to student-centered and competence-based in sustainable science higher education. Still, its change and coping strategies is considered as somewhat unfamiliar learning environment. Research examined students' engagement to the learning approach of a flipped-classroom model for sustainable science course with the Revised Two-Factor Study Process Questionnaire (R-SPQ-2F). It assesses research proposals, which students are utilizing to learning, and engagement and individual abilities as well. The research was conducted with the students enrolled in the "Atmospheric Pollution" course of the Environmental Science undergraduate program (n=64). The results obtained through the R-SPQ-2F showed the students' number reaching higher "deep approach" in their learning increased at the course end, while it can be observed that the students' number marking "surface approach" below the mean value was slightly lower (pre- and post-test comparison). It can be concluded that students are employing more engagement in their works and enhancing their personal skills as well with the teaching methodology. Results obviously specified that the study structure change was a phase into correct emphasis to improve students' engagement in the flipped sustainable science education.*

**Keywords:** *engagement, science learning, R-SPQ-2F, flipped-classroom, sustainable education, study approach.*

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## EXAMINATION OF STUDENTS' ENGAGEMENT WITH R-SPQ-2F OF LEARNING APPROACH IN FLIPPED SUSTAINABLE SCIENCE COURSE

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### Introduction

Currently, changing study structures in science education make students' engagement to be deemed important to research. Many researchers have mentioned that student engagement in every educational institution is his/her active commitment in learning activities (Carini, Kuh, & Klein, 2006; Christenson, Reschly, & Wylie, 2012; Symaco & Tee, 2019). Educational institutions should teach the students that they are learning from adaptive engagement to passionate engagement for knowledge attainments and long-term learnings (Biggs & Collis, 1982; Jang, Kim, & Reeve, 2016). In the classroom, engagement is a gauge and a guide of students' affirmative educational performing and performs as the mechanism and instrument via which the students show educational improvement, as a consistent and reliable interpreter of educational accomplishment (Ladd & Dinella, 2009; Reeve & Lee, 2014; Skinner, Kindermann, Connell, & Wellborn, 2009). However, a concern has been raised by itself for good reason among educators, which have been mainly intensified for students in science education with the substantiation of their science declines (Gottfried, Marcoulides, Gottfried, & Oliver, 2009; Sinatra, Heddy, & Lombardi, 2015; Vedder-Weiss & Fortus, 2011). Conventionally, students' engagement by scholars has been conceptualized: emotional engagement (enjoyment, interest, other affirmative emotions, etc.); multidimensional and behavioral construct (e.g. effort participation and attention, etc.); and cognitive elements (e.g. learning process regulation, etc.) (Fredricks, Blumenfeld, & Paris, 2004; Sinatra, Heddy, & Lombardi, 2015). These are mostly approachable and reactive to neighboring situations in the classroom, i.e. professors' independence help, arrangement, warmth and actual teaching utilization (Patall, Vasquez, Steingut, Trimble, & Pituch, 2017; Reeve, 2013; Skinner & Belmont, 1993). Thus, agentic engagement proposed has been students' constructive and proactive tries to affirm their intervention and impact of instruction flow (González-Gómez, Airado Rodríguez, Cañada-Cañada, & Jeong, 2015; Reeve, Nix, & Hamm, 2003; Reeve & Tseng, 2011). It is remarkable as a chance to

heightening various classroom activities and key developmental tasks of students' learning in science course (Eccles et al., 1993; Reeve, 2013). Therefore, the engagement of students is deemed significant to research due to study organization changes: course-grounded to student-centered and competence-grounded in the sustainable science higher education. Still, its change and coping strategies is somewhat unfamiliar learning environment.

In the higher education of different subject areas and countries, the Revised Two-Factor Study Process Questionnaire (R-SPQ-2F) was often employed to assess the students' study proposals (Biggs, 1987; Biggs, Kember, & dan Leung, 2001; Maznah & Yoong, 1995). In the theoretical and original construct of the Study Process Questionnaire (SPQ), it could be made by three different approaches such as surface, deep and achieving learning, which have had each motive and strategy sub-scale (Biggs, 1987; Wong, Lin, & Watkins, 1996). Each sub-scale includes seven elements and can be responded on a 5-point Likert scale. Sub-scale grades are analyzed by adding up the values on the pertinent matters to denote those who are making better usage of that exact learning strategy (Biggs, Kember, & dan Leung, 2001). However, many studies into the SPQ dimensionality have denoted surface and deep approaches as a two-factor solution have been the best fitted approach and have articulated a two-factor solution related to those in which the achieving learning sub-scale has split between the two factors (Kember & Leung, 1998; Snelgrove & Slater, 2003; Watkins & Akande, 1994). Due to these studies' findings and higher education altered nature such as students' amplified heterogeneity population and new teaching and valuation techniques, Biggs et al. (2001) have reviewed and adjusted the SPQ. As the revised version, the R-SPQ-2F has a short twenty-questionnaire on the basis of a 5-point Likert scale. It is very simply to employ and utilize. Learning approach of the students is categorized as surface while a student practices learning like an extrinsic responsibility that is required to move a course and he/she attempts to satisfy the courses' necessities with a least endeavor (Fryer, Ginns, Walker, & Nakao, 2011; Justicia, Pichardo, Cano, Berbén, & De la Fuente, 2008). Also, the learning approach of the students is classified as deep while a student practices learning like an intrinsic responsibility that has an intrinsic attention and assumes he/she will like learning (Fryer, Ginns, Walker, & Nakao, 2011; Justicia, Pichardo, Cano, Berbén, & De la Fuente, 2008). Deep Approach (DA) and Surface Approach (SA) comprise of two sub-scales. The 'Strategy' sub-scale is indicating the method that a student learns for the education and the 'Motive' sub-scale is indicating the causes for embracing a proposed strategy (Stes, De Maeyer, & Petegem, 2013). Thus, with the R-SPQ-2F, current research can target to extend our understanding of engagement by examining the study strategies which the students in a flipped-classroom model for sustainable science education course.

With the understanding of engagement to the students' study strategies and proposals with the R-SPQ-2F aforementioned, sustainable development in flipped (science) education is raising public awareness and is gaining an increasing importance to improve a long-term learning program (Eneroth, 2000; Lozano, Lozano, Mulder, Huisinigh, & Waas, 2013; Sterling, 2001). As a part of a universal structure, universities in higher education should suggest sustainability education that aims people along with capability and knowledge will reproduce on their performance effects (Barth, Godemann, Rieckmann, & Stoltenberg, 2007; Valcke, 1991; Wiek, Withycombe, & Redman, 2011). Science education, having a strong tie with sustainable development, is linked to knowledge that is embracing the sustainability education principles although a specific research can connect with its methodologies, capacities and competences, and technical and practical abilities (Bacelar-Nicolau, Caeiro, Martinho, Azeiteiro, & Amador, 2009; Esmaeilian, Rust, Gopalakrishnan, & Behdad, 2018). Especially, Sterling (2001) has specified that sustainability education has been an instructive and educational culture transformation for person's potential understanding, and social, economic and ecological interdependence, which could handle and lever into transformative education. Then, Mezirow (1997) in transformative learning has specified that the educators' accountability has been to contribute learners who could realize their targets in a more independent and accountable way. In the context aforementioned, the conventional science classes indicated by many studies have been not the most successful learnings for students though it has been a standard method to distribute courses over the past years (Butt, 2014; González-Gómez, Jeong, Airado Rodríguez, & Cañada-Cañada, 2016; Jeong, Cañada-Cañada, & González-Gómez, 2018). However, learning should not be entirely exposed like the knowledge allocation and distribution for the learners. The flipped-classroom, introduced to overcome these glitches, has been a fairly new teaching methodology (Jeong, González-Gómez, & Cañada-Cañada, 2019a; Munir, Baroutian, Young, & Carter, 2018; Tucker, 2012). Here, it aims to offer sufficient in-class time, which can conclude classroom task and can pursue a constructivist learning (Hill, Song, & West, 2009). Accordingly, as both traditional- and online/blended-classroom combination, a flipped/inverted-classroom can be envisaged that can be exploiting in-class and out-of-class period and are completing more effectual learning prospects and perceptions (Munir,



Baroutian, Young, & Carter, 2018; Tucker, 2012). Due to these reasons and the absence of literature and information, we seek to extend our understanding of engagement by examining the study strategies of the students in a flipped-classroom model for sustainable science education course with the R-SPQ-2F.

Student engagement research on learning approaches is very important to improve student learning quality while student involves actively in teaching and learning activities (Maznah & Yoong, 1995; Symaco, 2011; Symaco & Tee, 2019). Marton and Säljö (1976) have indicated learning approaches could be examined by the processing information and behavior of students. This research examined students' engagement to learning approach of a flipped-classroom model for sustainable science education course together with the R-SPQ-2F. It examined the study approaches, which the students are occupying to learning and the personal skills and engagement as well. As a validated and consistent questionnaire, the R-SPQ-2F can measure the students' deep and surface approach of a study.

#### *Research Aim*

Due to literature and proper methodology absence, particularly in sustainable science education, it was necessary to research the study strategies of the students in a flipped-classroom model for sustainable science education course with the R-SPQ-2F. Also, research problem was that students' engagement was in somewhat unfamiliar learning environment for sustainable science education due to study structure changes from course-based to student-centered and competence-based. Therefore, the aim of the research was the understanding of engagement through scrutinizing the study strategies of the students in a flipped-classroom model for sustainable science education course with the R-SPQ-2F along with the previous research extension. It can add the originality of the research proposed that there are no specific research to deal with these aspects all together that will give a novel approach. Particularly, this approach opens a new method to understand and extend the study engagement strategies which the students in a flipped-classroom model for sustainable science education course with the R-SPQ-2F.

#### *Research Focus*

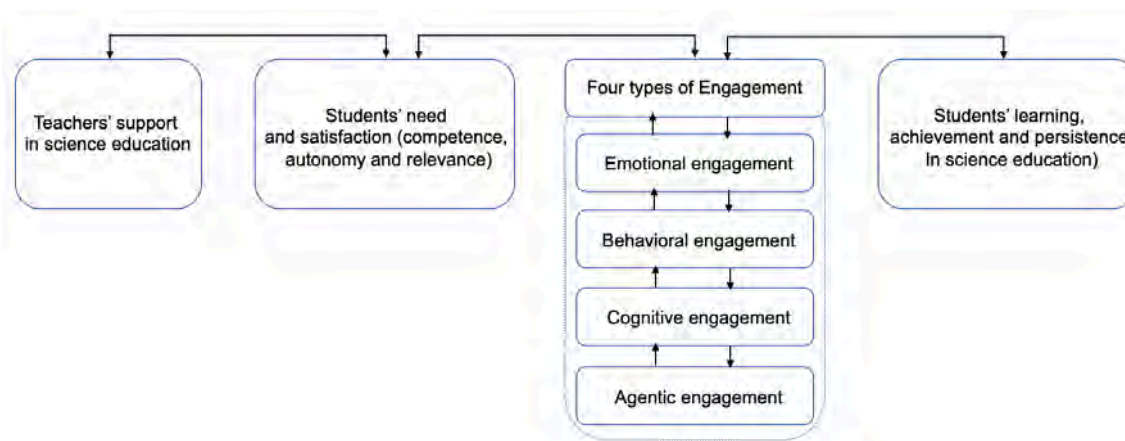
Research focused on 1) knowing the students' engagement of learning approach in a flipped-classroom model for sustainable science course and 2) knowing the connection between the students' engagement of learning and learning outcomes.

### **Research Methodology**

#### *General Background*

The R-SPQ-2F was applied into a course of "Atmospheric Pollution" for the Environmental Science undergraduate program. As a core course in the program, this course contained various sustainability themes, its transitions, changes and theories. Considering the subject proposed, it analyzed whether the R-SPQ-2F could yield the positive results by examining into the rationality and consistency. Then, in pre-, and post-test of a flipped-classroom model for sustainable science course, the R-SPQ-2F has been applied to assess the engagement of learning approach of the students, one with a deep and the other with a surface learning approach. A conceptual model of R-SPQ-2F valuation describes how engagement is working in educational institutes as shown in Figure 1. Assessing students' engagement of a flipped-classroom model for sustainable science education course with the R-SPQ-2F, the methodology is used for various steps as depicted in Figure 1.





**Figure 1.** A conceptual framework in a science-classroom showing how the engagement works.

### Sample

The research was conducted along with the students enrolled "Atmospheric Pollution" of the Environmental Science undergraduate program at the National Distance Education University (Spain) for the 2017/18 year. The subject was taught in the third year of the Bachelor of Science program and is compulsory for all students. The students' total number enrolled in the 2017/18 course was 192 students. However, although the initial questionnaire was answered by 103 students (53.65%), only 64 students answered and completed all the questionnaires (33.33% and 62.14%, respectively). The sample characteristics are recapitulated as shown in Table 1. While it is described (see Table 1), the highest percentage of the students were between 30 and 40 years old and they have entered the Bachelor's degree after finishing high school. About 70% of students are working while they are studying and the relationship between men and women is almost the same size.

**Table 1.** Sample descriptions participating in this research.

Characteristic		Students participated
Number (n)		64
Gender (%)	Male	46.9
	Female	53.1
Age (%)	< 25	6.3
	25 - 30	20.3
	30 - 40	50.0
	> 40	23.4
Part-time student (%)	Yes	68.8
	No	31.3
Former study background (%)	Professional school	26.6
	High school	39.1
	Other backgrounds	34.4

### Course Context

The subject was taught in the third year of the Bachelor of Science program and is compulsory for all students. As a core program, this course contains various sustainability themes, its transitions, changes and theories.



Particularly, the content of this subject has been structured in ten teaching units. They include the fundamental aspects of the dispersing medium, the atmosphere, and atmospheric pollutants, their origin and local, regional and global effects. Also, the follow-up and control measures, and the legislation developed to that effect. After the course completion and conclusion, it is expected that the learners have acquired the specific competences related to the contents and are able to identify the problems and opt for the measures to be taken to mitigate the effects for the sustainability. The course follows the methodology of a flipped and distance instruction methodology, and, in accordance with the assigned teaching plan, students require a total of 125 hours to obtain the proposed competences (5 credits). All students have a basic text adapted to the methodology, a didactic guide that includes, among others, the work plan, details about the evaluation system, etc. Students also have a virtual classroom with different communication tools and online interaction, such as forums and chats. In addition, information and complementary materials self-assessment exercises, quizzes, etc.

#### *Instrument and Procedures*

Science engagement of learning approach in a flipped-classroom model for sustainable science course was measured through a pre-, and post-test questionnaire, which were provided to students before and after completing the course. Using the online format, the questionnaire on pre- and post-test was established. Then, the web link was remitted to each participant. The initial questionnaire has been expanded including questions about gender, age, former education, full or part time student, etc. to know the profile of the participants. In all the questionnaires, a section has been included so that the student can make any comments related to the subject. During the survey, no constraints were executed, and the participants spontaneously selected whether they desired to partake in the research survey.

For this research, students' engagement of learning approaches was determined through the R-SPQ-2F adapting questions from Biggs et al. (2001) that has 20 questions with a 5-point Likert scale employed. Precisely, the survey questions comprised of a two-factor solution, that is, 10 questions for DA and 10 questions for SA with 5 levels scale (for me, this question is never correct = 1, this for me, this question is sometimes correct = 2, for me, this question is correct approximately half of time = 3, for me, this question is often correct = 4, and for me, this question is always correct = 5). Also, its validity and reliability were tested by means of the Cronbach alpha test. According to Biggs et al. (2001), validity and reliability of the R-SPQ-2F is acceptable when the Cronbach's value  $\alpha$  test for DA and SA constructions indicated to 0.73 and 0.64. The survey question contributes a suggestion of how a student deems to reach studying approaches. A difference was completed between when a DA studying is a student is having an inherent attention and likes in studying, and a SA to studying whereby a student intends to satisfy the course requirement with a least effort. Both scales, DA and SA, comprise two sub-scales, that is, the 'Strategy' sub-scale is concerning the method that a student learns concerning study and the 'Motive' sub-scale is concerning the causes for embracing a study strategy (Stes, De Maeyer, & Petegem, 2013). It also contains four subscales: motivation and deep study strategy such as Deep Motive (DM) and Deep Strategy (DS) and motivation and superficial study strategy such as Surface Motive (SM) and Surface Strategy (SS). Current research with the R-SPQ-2F can target to extend our understanding of engagement by examining the study approaches, which the students in a flipped-classroom model for sustainable science education course.

#### *Data Collection*

Before starting the survey, all the instruments and protocols to collect data were approved by the university bioethics committee. In this research, the participation was totally voluntary. Also, no personal data was logged for any participants. Questionnaires were provided to the participants at the course initiation, and once the semester was done. Data collected from the R-SPQ-2F questionnaires consisting of 20 questions were analyzed as described by Biggs et al. (2001). For DA or SA to get the students' score, students' points were added up for each question group, DA or SA, thus, for each approach, 50 points was the maximum score for each student. Similar analysis was carried out to assess the students' engagement and approach to learning, considering four different sub-categories' questionnaire, which were the DS, DM, SS and SM groups. Scores of the participants were analyzed as adding up the scores given for a particular group of questions as described by Biggs et al. (2001). For its validity and reliability, the Cronbach alpha test was performed.





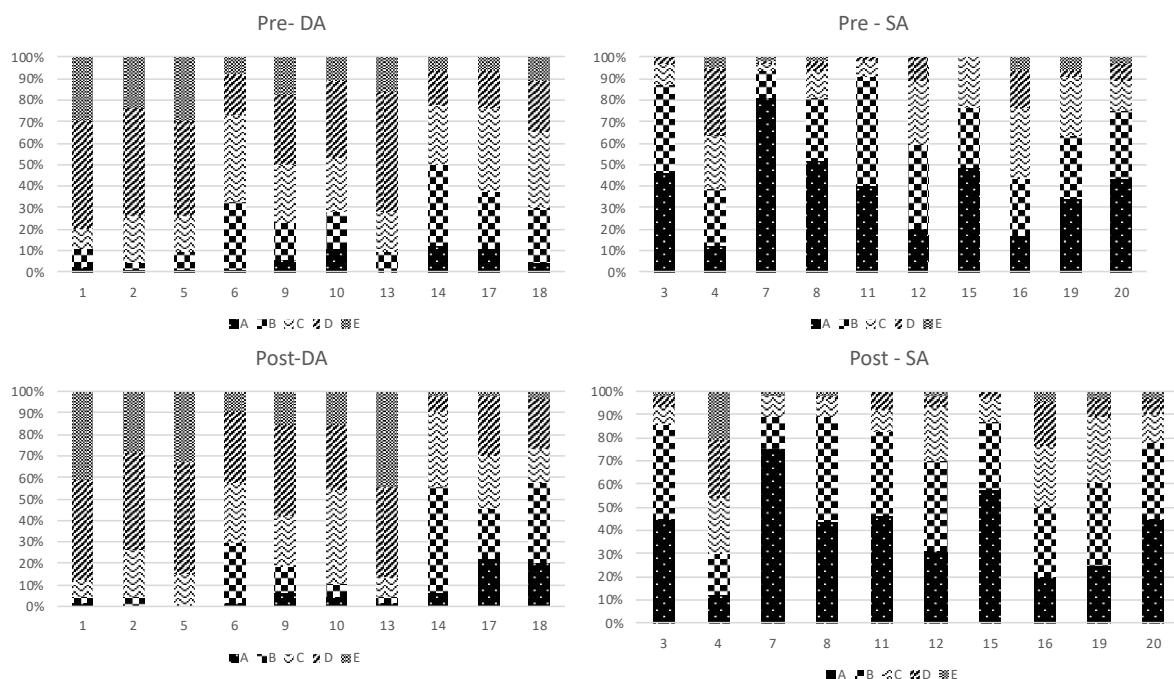
**Research Results**

With the particular and original publications such as Pintrich and De Groot (1990), Ahlfeldt, Mehta, and Sellnow (2005), and Biggs et al. (2001), each part questionnaire validity and reliability has been verified. Table 2 shows the Cronbach Alpha test value for the learning approaches' scales. In a two-factor solution, the question's validity to learning gauging the DA was 0.72 and the SA was 0.81. Biggs et al. (2001) for their sample stated that the values of Cronbach alpha test for the R-SPQ-2F were 0.73 for the DA and 0.64 for the SA. Therefore, for both the DA and SA, the Cronbach alpha test can be concluded as satisfactory.

**Table 2. Cronbach Alpha test values comparison with Biggs et al. (2001).**

Variables	Questions	Cronbach Alpha value for this work	Cronbach Alpha value
DA	10	0.72	0.73
SA	10	0.81	0.64

Biggs et al. (2001) showed the instructions on how to acquire the DA and the SA score are arranged. In the scale, ten questions are for the DA learning and for the SA learning. The DA is consisting of questions 1, 2, 5, 6, 9, 10, 13, 14, 17 and 18. Then, the SA is consisting of questions 3, 4, 7, 8, 11, 12, 15, 16, 19 and 20. Both questions are to attain the DA and SA scores for each core measure. The students' answers were obtained as the five different scales: for me, this question is never correct = 1 (A), for me, this question is sometimes correct = 2 (B), for me, this question is correct approximately half of time = 3 (C), for me, this question is often correct = 4 (D), and for me, this question is always correct = 5 (E). Then, the DA and SA grade is calculated as follows: DA=1+2+5+6+9+10+13+14+17+18 and SA=3+4+7+8+11+12+15+16+19+20. Figure 2 shows the frequency of scores given for each item by the participants of the research before starting the research as pre-test, and after the course completion as post-test. The scores' dissemination in Figure 2 displayed a specific pattern for the DA, the higher scores are recorded in the post-test answers, while the lower scores for the SA are also recorded for the post-test answers.



**Figure 2. Scores' frequency of given for each item by the participants of the research (pre- and post-test).**

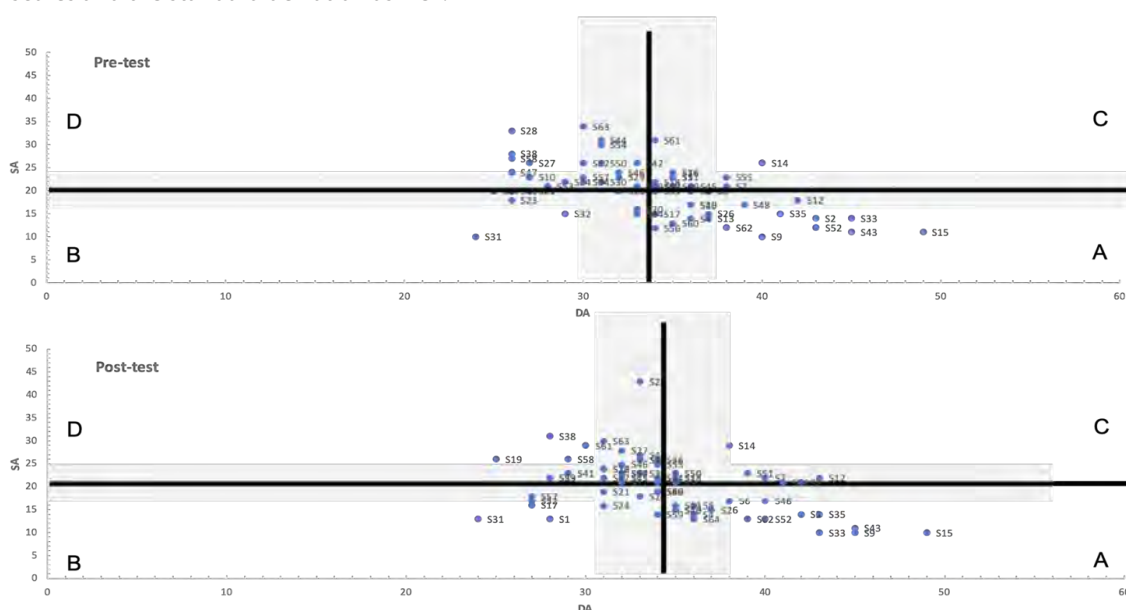


According to the results summarized in Figure 2, the frequencies of D and E scores given by the students increased after the course. The instrument items in which this increment was more accentuated were item 1, "I detect sometimes studying offers me a deep personal gratification", item 2, "I detect I should do sufficient effort on a topic in order to make my own decisions before personal gratification" and item 13, "For my studies, I work hard when I detect the motivating material". In the item 13 case where 44% of the students indicated "this question is always true for me" after the course (post-test) while only 15% of the students gave the same answer before starting the course (pre-test). Regarding the surface approach, the difference in frequencies was similar before and after the course, however it was outstanding that, in all instances, students gave low scores for SA items. Thus, considering the DA scores, the number of students with higher scores in the final questionnaire increased. In contrast, the number of students who gave lower superficial focus scores also increased. In the initial questionnaires, 34 students had lower scores than the average DA scores, while in the final questionnaires 25 students with lower scores than the average DA scores, but many of them very close to it. In the case of SA scores of the initial questionnaires, 24 students presented scores that were lower than the SA average, and in the final questionnaires, 29 students presented scores that were lower than the SA average. Likewise, when the DA and SA values revealed a minor variance, which denoted a non-preferential approach (Hamm & Robertson, 2010). Table 3 shows the summary of the results obtained in the two questionnaires based on their mean (*M*), standard deviation (*SD*), lowest and highest score. The mean value of the scores given for the DA went from 33.7 (pre-test) to 34.4 (post-test), while the SA remained in 20.2 in both cases. Hamm and Robertson (2010) indicated that DA scores that were more the mean worth identified a DA for the learning of study subject.

**Table 3. DA and SA questionnaires' response: mean, standard deviation, lowest and highest score.**

Test type	DA/SA	<i>N</i>	<i>M</i>	<i>SD</i>	Lowest score	Highest score
Pre-test	DA	64	33.7	5.4	24	49
	SA	64	20.2	5.7	10	34
Post-test	DA	64	34.4	5.2	23	49
	SA	64	20.3	6.1	10	43

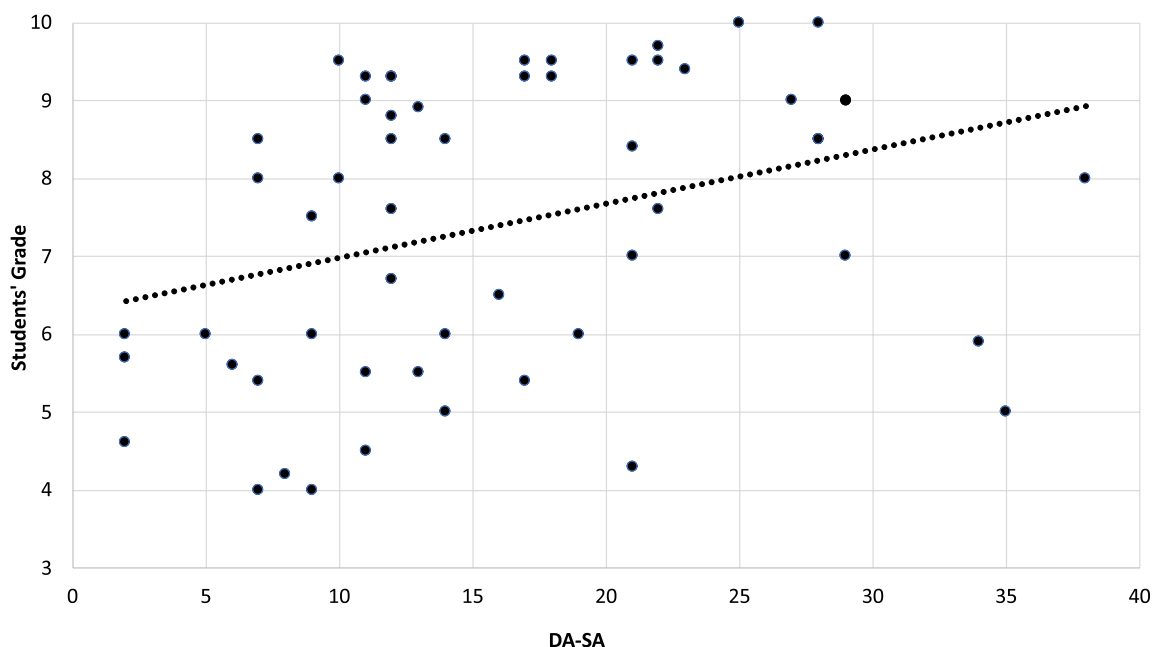
The scores' dissemination specified by the students before and after the course (pre- and post-test) was depicted on a XY-graph in Figure 3 as to get its better view. This figure also included the mean value for the DA and SA scores and the standard deviation as well.



**Figure 3. DA and SA distribution of scores for each student between pre- and post-test for the course. With the black line, mean values are denoted and with the gray shaded area the standard deviation is indicated for the DA and the SA.**

Considering the mean value lines displayed for DA and SA scores, Figure 3 could be divided in four square sections (A, B, C and D). In square A, students had a score more than the DA mean value and less than the SA mean value. On the other hand, the square D shown in Figure 3 that represented participants with DA scores less than the mean value and SA scores more than the mean value slightly decreased in the post-test plot when was compared with the pre-test score. Finally, the students who had scores above the DA mean value and below the SA mean value were situated in square C, while square B showed the students whose scores were below the DA and SA mean values. According to Kubischta (2014), this plot could be used to categorize the students like partaking a deep, intermedia or surface learning approach. Thus, students belonging to square A denoted an inclination for a deep learning approach, while those located in the D square showed a preference for a surface approach learning. Reflecting the plots through pre- and post-test, the students' number situated in the square A moved from 16 to 20. This increase was mostly due to the reduction of the SA scores given by the students. An intermedia situation or a non-dominant learning approach corresponds to all the students depicted in squares B or C. The number of students located in these two squares (B or C) decreased once the course was completed.

The influence of the students' learning approach and the outcomes of learning registered at the end of the course was as well evaluated. Figure 4 represents the X-Y scatter plot of the dissimilarity between the DA and SA scores and the participants' final grade.



**Figure 4.** X-Y scatter plot of the difference between DA and SA approach to learning vs. students' learning outcomes in terms of final grade.

In Figure 4, the lower difference values between DA and SA referred to those students whose SA scores were higher (students located in square D depicted in Figure 3). On the other hand, the higher difference values between DA and SA referred to those students whose DA scores were higher (students located in square A represented in Figure 3). According to the results shown in Figure 4, a positive correlation could be found between the differences DA-SA and the participants' grade indicating  $r=.32$  and  $p<.05$ . The number of students with lower grades were correlated with lower DA-SA difference values.

## Discussion

Owing to a certain students' learning approach, Hamm and Robertson (2010) criteria were followed in this research, thus it was reflected that an over mean value DA indicated a deep and an over the mean value SA indicated a surface approach. In accordance with this research results, students, at the semester end, had a general inclination





for a deeper learning approach (Figures 2 and 3). In fact, the results showed that the number of students reaching a DA to learning increased while the number of students reaching a SA to learning decreased at the semester end. The shift of the students' learning preference during the course could be explained, as it was appointed by Zeegers (2001), by the fact that the students' engagement with course requirements was rewarded by better results, also because they showed more interest in the course contents and finally, by the teaching and learning activities carried out in the course. In this sense, the teaching methodology implemented in this course was based on the flipped-classroom teaching/learning model. A fairly new teaching methodology of a flipped-classroom (Jeong, González-Gómez, & Cañada-Cañada, 2019b; Munir, Baroutian, Young, & Carter, 2018; Tucker, 2012) that aims to offer sufficient in-class time, which can conclude classroom task and can pursue a constructivist learning (Hill, Song, & West, 2009). Accordingly, as both traditional and online/blended education combination, a flipped-classroom can be envisaged as exploiting in-class hour and out-of-class hour and accomplishing better learning prospects and perceptions (Munir, Baroutian, Young, & Carter, 2018; Tucker, 2012). Adopting a deep approach the students denoted that they were not only attentive for the educational job, but also, they were appreciative for the procedure of performance (Biggs, 1987; Mokhtar, Choo, Husain, & Rahman, 2010).

In the flipped science education, to satisfy the sustainable development with the engagement understanding into the students' study strategies with the R-SPQ-2F, Eneroth (2000) mentioned its raising public awareness and was gaining an increasing importance to improve a long-term learning program. Thus, Barth, Godemann, Rieckmann, and Stoltenberg (2007) suggested sustainability education aimed that people along with capability and knowledge could reproduce on their performance effects in higher education. With the increase of a DA and decrease of a SA through this research, a specific research linked to sustainability knowledge and principles embraced its methodologies, capacities and competences, and technical and practical abilities (Bacelar-Nicolau, Caeiro, Martinho, Azeiteiro, & Amador, 2009; Esmaeilian, Rust, Gopalakrishnan, & Behdad, 2018). Like Sterling (2001) specified, sustainability education was a transformation of instructive and educational culture for person's potential understanding, and social, economic and ecological interdependence. These could be transformative education to being handle and lever. Then, in transformative learning, Mezirow (1997) specified that the educators' responsibility was to provide learners who could comprehend their goals a more accountable and independent approach. So, the conventional science classes indicated by many studies could be overcome to be the most successful learnings for students through the flipped-classroom methodology introduced (González-Gómez, Jeong, Airado Rodríguez, & Cañada-Cañada, 2016; Jeong, Cañada-Cañada, & González-Gómez, 2018). We found out to spread general understanding of engagement by studying the strategies of the students in a flipped-classroom model for sustainable science education course with the R-SPQ-2F.

Along with the engagement examining the study strategies of the students in a flipped-classroom model for sustainable science course with the R-SPQ-2F, the students' engagement learning/academic relationship, students' learning/academic approach and learning/academic effects were reported to show inconsistent results (Zeegers, 2001). The results presented in this study (Figure 4) showed a positive correlation ( $r=.322$  and  $p<.05$ ) between the DA-SA differences and the students' grade. Watkins and Hattie (1981) also found positive correlations between the results provided by the R-SPQ-2F instrument and the students' learning achievements in a longitudinal study conducted with 249 university science students. On the other hand, Zeegers (2001) reported that a constant positive correlation could be found between the annual Grade Point Average (GPA) and the deep approach, and there was a small negative correlation with the surface approach. Watkins (1996), and Pintrich and De Groot (1990) indicated in their works that the correlation between students' learning approach and the outcomes of learning were also influenced by the factors such as students' self-confidence and students' self-efficacy. In that sense, Jeong, González-Gómez and Cañada-Cañada (2019) reported that a science course following a flipped-classroom teaching approach allowed to shape a more positive teaching/learning setting. Here, toward the course students' emotions and perceptions were improved, together with the students' academic self-efficacy. That is in accordance with the results showed in this research.

## Conclusions

The present research explored the students' approach to learning in a course of "Atmospheric Pollution" for the Environmental Science undergraduate program. To explore whether participants adapted a deep or surface approach to learning, the R-SPQ-2F was employed. The R-SPQ-2F results showed that the students' number reaching a DA in learning increased at the class end. Moreover, the participants' number showing a SA to learning decreased



within the course. Among the different factors that were described to affect the students' approach to learning, the teaching approach respected in the course was one of the them. In this research, a flipped-classroom model was followed resulting in an increment of the participants' number reaching a deeper approach to learning. Regarding with the outcomes of learning acquired, a positive correlation was discovered in the context of the relationship of the educational learning achievements and the students' learning approach. Students' reaching a deeper approach to learning achieved as well better learning outcomes. Thus, it could be concluded that the students were employing more engagement in their educations and refining their individual skills as well with the proposed teaching methodology. Results obviously designated that the study structure change of the course suggested was a stage into the correct path to improve students' engagement in flipped sustainable science education.

While the methodology suggested overcame the current research glitch and difficulty, the study strategies of the students in a flipped-classroom model for sustainable science education course with the R-SPQ-2F added the new value to previous reports. Also, the increased study strategies more to deep approach practically improved students' academic work and their enjoyment of the course processes while adapting the study structure such as student-centered and competence-based considering students' engagement. It can add to the originality of the research proposed that there are no specific research to deal with these aspects all together that will give a novel approach. Therefore, it showed that the results allowed to figure a much more affirmative teaching/learning atmosphere. Here, the perceptions and emotions of participants concerning the course were perfected, together with the students' academic self-efficacy along with the students' engagement for a flipped-classroom model for sustainable science course with the R-SPQ-2F.

### Acknowledgements

The authors gratefully acknowledge the Regional Ministry of Economy and Infrastructure of Extremadura and European Social Fund (Projects IB18004 and GR18004) and the Project EDU2016-77007-R (AEI/FEDER, UE) of the Ministry of Science, Innovation and Universities of Spain, which support this work possible.

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Received: September 10, 2019

Accepted: December 02, 2019

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