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Students' Perceptions and Emotions Toward Learning in a Flipped General Science Classroom

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Abstract Recently, the inverted instruction methodologies are gaining attentions in higher educations by claiming that flipping the classroom engages more effectively students with the learning process. Besides, students' perceptions and emotions involved in their learning process must be assessed in order to gauge the usability of this relatively new instruction methodology, since it is vital in the educational formation. For this reason, this study intends to evaluate the students' perceptions and emotions when a flipped classroom setting is used as instruction methodology. This research was conducted in a general science course, sophomore of the Primary Education bachelor degree in the Training Teaching School of the University of Extremadura (Spain). The results show that the students have the overall positive perceptions to a flipped classroom setting. Particularly, over 80 % of them considered that the course was a valuable learning experience. They also found this course more interactive and were willing to have more courses following a flipped model. According to the students' emotions toward a flipped classroom course, the highest scores were given to the positive emotions, being fun and enthusiasm along with keyword frequency test. Then, the lowest scores were corresponded to negative emotions, being boredom and fear. Therefore, the students attending to a flipped course demonstrated to have more positive and less negative emotions. The results obtained in this study allow drawing a promising tendency about the students' perceptions and emotions toward the flipped classroom methodology and will contribute to fully frame this relatively new instruction methodology.

Keywords Blended learning · Flipped classroom · Instruction methodology · Inverted methodology · Pre-service teacher · Student-centered learning activities

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Introduction

The flipped classroom paradigm or inverse instruction methodology (IIM) was firstly coined by Jonathan Bergmann and Aaron Sams (Tucker 2012). This relatively new instruction methodology has its foundations in the constructivism and the social learning theory (Hill et al. 2009) and states that "direct instruction and lecture is not an effective teaching tool in the group learning space, but is effective when delivered to individual" (Sams and Bergmann 2013; Bergmann and Sams 2014). In a regular flipped classroom, lectures are delivered to home by means of video-lectures, together with written materials and online tasks and quizzes (Tourón and Santiago 2015; González-Gómez et al. 2016). So, in-class time is used to work in more student-centered learning activities, thereby making interactive courses (Moraros et al. 2015) or delivering just-in-time lectures to address specific questions. A flipped

classroom setting could also be understood as a combination of both traditional and online education by employing in- and out-of-class time, accomplishing more efficient learning opportunities (Young 2002; Mattis 2014). A main character of this instruction methodology is that students have more responsibility in the learning process (O'Flaherty and Phillips 2015). Therefore, their perceptions and emotions, when a flipped classroom setting is followed, must be gauged in order to completely frame this methodology.

Based on the available literatures, a general positive perception toward a IIM is mostly described for different educational levels and conditions (Roach 2014; Calik et al. 2015; Gilboy et al. 2015; Sowa and Thorsen 2015; González-Gómez et al. 2016; Long et al. 2016). These positive perceptions are not only related with the instruction methodology, but also a majority of students mentioned that the teaching instruments applied in a flipped classroom setting were convenient and useful as a learning tool (Butt 2014; Sowa and Thorsen 2015). Precisely, the features positively perceived by the students in a flipped classroom setting are referred that the possibility to watch video-lectures and other supporting materials before the class contributes to succeed in the proposed learning goals (González-Gómez et al. 2016). In the same line, Roach (2014) highlights that the ability to watch or re-watch the flipped materials allowed students to overcome difficulties related with more complex concepts. Moreover, the nature of the activities accomplished in a flipped classroom setting is as well positively perceived by students (Handelsman et al. 2004).

On the other hand, an important number of researches have already pointed out the connection between the cognitive and affective dimensions in the teaching and learning process (Hargreaves 2000; Sutton and Wheatley 2003; Borrachero et al. 2014). According to Tobin (2010), emotions act as a social glue that interconnects individual and collective interests and actions in the learning process. Thus, the constructivism theory is approaching to emotions as important dimensions in teaching and learning environments (Ross 2012). Emotions can be defined as the reaction to the information that a person receives from its relation with the environment and whose intensity depends on subjective assessments that are made on them (Bisquerra 2005). The initial knowledge and beliefs, that a person has, make a significant influence in such subjective assessments. Emotions are involved in all persons' actions, because there is not any human action without an emotion that makes it possible (Otero 2006), and therefore are essential for a decision-making (Damasio 1996). The conceptual change must be achieved from a cognitive and affective approach (Thagard 2008). Besides, teachers ignoring the emotional aspects associated with the learning process might limit their conceptual change (Duit et al. 2008). Precisely, in a Science, Technology, Engineering and Mathematics (STEM) course, emotions play a key role to achieve a significant learning (Pintrich et al. 1993). In fact, positive emotional states foster the learning of science and increase the students' commitment as active learners, while negative emotions limit the ability to learn (Vázquez and Manassero 2007; Aydogan et al. 2015). Different studies have already pointed out that students' emotional rejection is one of the school failure' causes, specially, in STEM course on which students feel mostly negative emotions and attitudes (Brígido et al. 2010; Solbes 2011; Brígido et al. 2013). Therefore, an appropriate instruction methodology and teaching strategies able to increase the positive emotions and/or reducing the negative ones could have a positive impact in the learning process.

The main objective of this research was to assess the students' perceptions and emotions when a flipped classroom setting is followed as instruction methodology. The study was conducted in a general science course, sophomore of the Primary Education bachelor degree in the Training Teaching School of the University of Extremadura (Spain) during the course 2015/2016.

Methodology

In order to measure the students' perceptions and emotions toward a flipped learning setting, a study was conducted in a general science course during the second semester of 2015/2016 year. The syllabus of this subject includes general topics about science and is summarized in Table 1. The subject is compulsory for all students and is taught in the second semester of the course in a 4-h/week setting. This study complements a previous study about the suitability of a flipped classroom model in terms of performance and perception that was conducted in the same course 2014/2015 (González-Gómez et al. 2016). For this study, an IIM was followed and the students were surveyed about their perceptions and emotions when the course was about to finish. Three sections of questionnaire, previously validated, were used as an instrument to collect students' socio-demographic information, perception and emotion questions. Figure 1 shows the working flowchart followed in this course.

Sample

In this study, a flipped learning method was implemented in general science course, a sophomore of the Primary Education bachelor degree in the Training Teaching School of the University of Extremadura (Spain) during the second semester of 2015/2016. A total of 88 students were enrolled

Table 1 Schematic syllabus of the general science course taught in the spring semester of 2015/2016

Chapter	Title	Main contents of theoretical classes	Hours
1	Teaching and learning Science in primary education	Scientific literacy	19
		Science in primary Education	
		Instructional models	
		Strategies, techniques and resources to teach science	
2	The Universe	Origin and evolution of Universe	33.5
		The Universe fundamental structures	
		The Solar system	
		The Sun	
		The Earth	
		The Moon	
		Sun-earth-moon models for primary education	
3	The matter	Physical and chemical properties of the matter	32
		Matter properties due to the interaction	
		Atomic models	
		Substances and mixtures	
		Density	
		Mechanics and fluids mechanics	
4	The matter transformation	Physical changes	33.5
		Thermodynamics	
		Chemical changes. Chemical reactions	
		Nuclear changes	
5	The energy	Type of energies	32
		Transformation, transfer, degradation and conservation	
		Energy use and transformation	
		Light and sound	
		Electric energy. Circuits. Magnetism	
		Energy, society and environment	

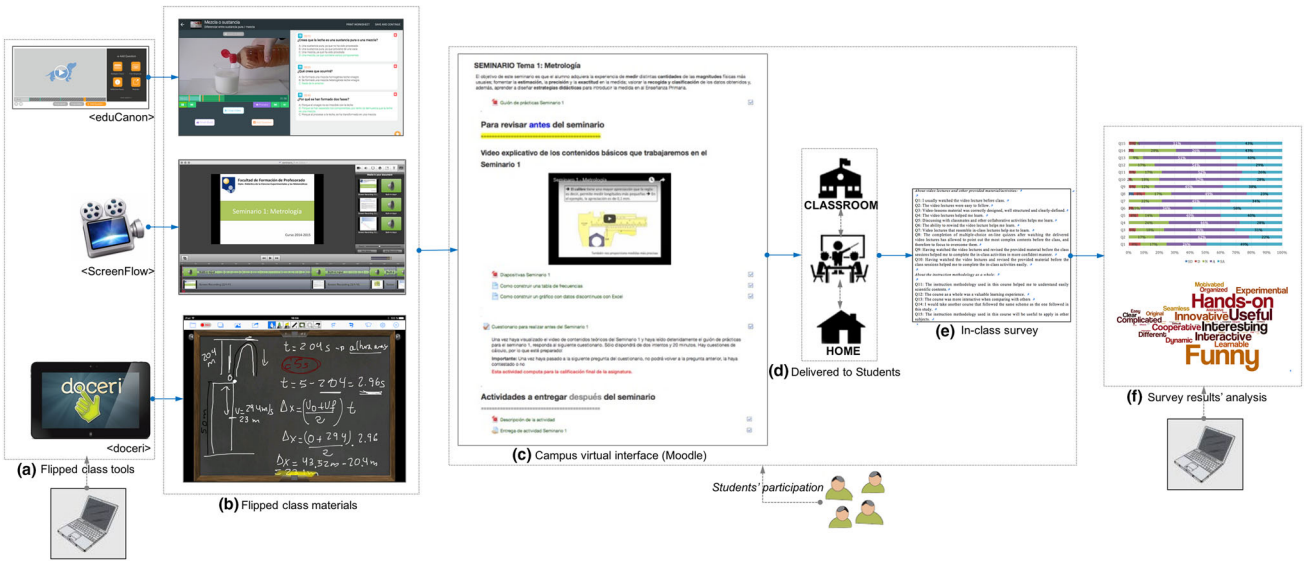

Fig. 1 Flowchart of IIM perception and emotion analysis process

in the course; among them 65 students were participating in the study. The rest of students were not attending regularly to the class. Regarding the demographic information of the participants, 65 % were males and 35 % females, being the average age of the participants 21 years old. The grade point average (GPA) at the beginning of the second semester was 6.95 ± 0.43 (7.26 and 6.63 in females and males, respectively). Based the information aforementioned, the educational background of the participants is summarized in Fig. 2.

Instructional Design

The flipped paradigm was introduced to the students at the beginning of the semester, together with the course flowchart where all the important dates and course actions were scheduled. The class scheme was consisted in 3 sessions of 50 min weekly to work theoretical contents and 1 session per groups of 50 min weekly of laboratory and collaborative works. In order to deliver the flipped class contents, all students had access to a Moodle virtual interface, where all contents were made available according to the class flowchart schedule.

Specifically, the course syllabus was structured in five sections (Table 1), and a different number of theoretical and laboratory classes was assigned according to its contents and difficulties. For each syllabus section, the class scheme was as follows: 1 week before starting the new section, the students were provided with different video-lessons, written materials and flash simulators of scientific contents. The students were asked to watch the videos before the class and to read the different materials according to the class schedule. Apart from the video-lessons provided, the students were also distributed with a multiple-choice online quizzes to review class contents and to give some feedback to the professor before the class in pursuance of delivering short "just-in-time" lectures as required. All videos and supporting materials were available online during the whole course for the students to be able to retrieve and re-watch them.

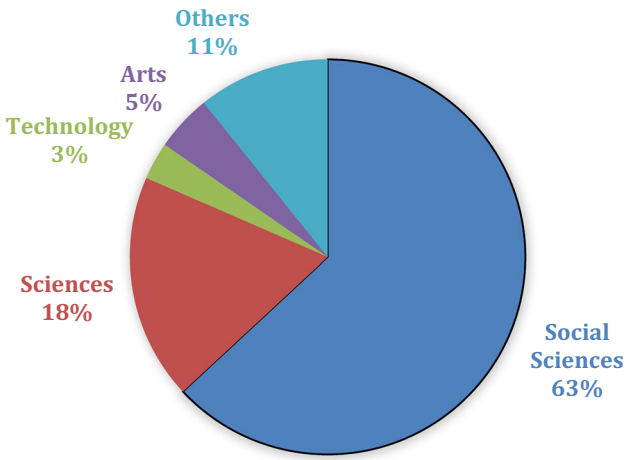

Fig. 2 Distribution of the participants by pre-university educational background ($N = 65$)

Although an active learning was followed in the whole course, the laboratory and collaborative class (50 min weekly) was exclusively devoted to the application of the materials that had been learning in the video-lessons and online materials provided through the virtual interface. In order to make a better learning environment, the laboratory classes were broken into three groups of 22, 22 and 23 students, respectively, and were assigned to different times. With this teaching structure, in the laboratory classes, the students spent the in-class time working on different problem sets such as numerical and non-numerical works designed by the professor. Also, they were using materials published, small group discussion and case studies, where the professor gave to the students a real-world problematic situations related with the lesson contents reviewed in the video-lessons. The professor role in these sessions was to observe, address concerns and deliver clarifications when they needed. By the end of each lesson, the students had to submit a working report with all tasks accomplished for its evaluation.

Therefore, with this class setting, the students had the opportunity to use the in-class time working on more engaging activities instead of being passively listening and note-taking. Figure 1c shows a screenshot of the virtual campus with the contents of one syllabus section. Regarding the flipped materials, most of them used in the course was already prepared by the authors for a previous study (González-Gómez et al. 2016).

Students' Perceptions and Emotions

With the aim of measuring students' perceptions and emotions toward the IIM described, two questionnaires were used as the instrument to collect students' information. The survey was distributed to the students in the last part of the semester, when the course was about to finish. To ensure the maximum participation possible, the students completed the survey in a class session. Furthermore, the students were asked to complete basic information about demographic aspects such as gender, age, educational background and grade point average (GPA) at the beginning of the second semester.

Regarding the students' perceptions, a five-point Likert-type questionnaire was used. Precisely, the questionnaire was adapted from Roach (2014) and was applied to the sample study, and for each statement, the participants were asked to provide their opinion form strongly disagreed

(SD), disagreed (D), neutral (N), agreed (A) and strongly agreed (SA). The test was consisted in 15 closed questions where the students could express their opinion about the followed methodology (IIM). The questions were divided into two groups, the first group of questions, from Q1 to Q10, the students were asked about the video-lectures and other provided materials and activities, such as the usefulness of the provided materials and how the before class activities helped the learning process and the achievements of course skills. In the second part of the questionnaire, from question Q11 to Q15, the students were surveyed about the instructional methodology as a whole and the course valuable learning experience. The list of questions is summarized in Table 2. Additionally, the students were asked to provide their global opinion of the instruction methodology as a whole by the means of five keywords. Also, they could provide any comments as their will.

On the other hand, in order to assess students' emotions evolved in the learning process when a flipped classroom setting was followed, a survey-based study was conducted. For this purpose, a prose-designed questionnaire based on previous studies conducted by our research group was considered (Borrachero et al. 2014; Dávila Acedo et al. 2015). The emotions taken into consideration in this study were sorted in two groups, namely positive and negative emotions (Bisquerra 2005; Damasio 2005). Positive emotions included fun, confidence, enthusiasm and tranquillity, while the negative ones were nervousness, concern, boredom and fear (Dávila Acedo et al. 2015). For each emotion, the participants were asked to measure the frequency of happening by a 0–10 scale, where 0 meant the lowest frequency of occurrence and 10 the highest frequency of occurrence. In addition, for each emotion, the participants provided a brief explanation of the score given.

Statistical Analysis

The data from the completed questionnaires were processed using statistical software SPSS. A descriptive analysis was firstly performed for being described as the most appropriate way to characterize, describe and draw conclusions from the sample data (Etxeberria and Tejedor 2005; Borrachero et al. 2014; Jeong et al. 2014). Then, to analyze the keywords frequency employed by the students to describe the course as a word map was constructed. The size of word represents how frequent each word was used. Finally, regarding the emotions results, a Chi-squared test was applied at 95 % and 99 % confidence level to determine the relationship between emotions. Score mean values of emotions by gender were particularly compared to determine the existence of significant differences by means of t test (95 % confidence level).

Results and Discussion

Perceptions' Evaluation

After the instruction, a post-task questionnaire was carried out to evaluate students' perceptions to the IIM. The

Table 2 Five-point Likert-type survey used in this study

About video lectures and other provided materials/activities
Q1: I usually watched the video lectures before the class
Q2: The video lectures were easy to follow
Q3: Video-lessons material was correctly designed, well-structured and clearly-defined
Q4: The video lectures helped me to learn
Q5: Discussing with classmates and other collaborative activities helped me to learn
Q6: The ability to rewind the video lectures helped me to learn
Q7: Video lectures that resembled in-class lectures helped me to learn
Q8: The completion of multiple-choice on-line quizzes after watching the delivered video lectures allowed to point out the most complex contents before the class, and therefore focused to overcome them
Q9: Having watched the video lectures and revised the provided materials before the class sessions helped me to complete the in-class activities in more confident manner
Q10: Having watched the video lectures and revised the provided materials before the class sessions helped me to complete the in-class activities easily
About the instruction methodology as a whole
Q11: The instruction methodology used in this course helped me to understand easily scientific contents
Q12: The course as a whole was a valuable learning experience
Q13: The course was more interactive when comparing with others
Q14: I would take another course that followed the same scheme as the one followed in this study
Q15: The instruction methodology used in this course will be useful to apply in other subjects

questionnaire followed a five-point Likert-type scale (from strongly disagreed to strongly agreed). The test was consisted in 15 closed questions divided in two sections: The first one was concerning the "flipped" materials, and the second was about the methodology as a whole. In order to get more information about the students' perceptions, they were asked to include five keywords reflecting their global opinion of the instruction methodology.

The questionnaire was provided to the students in a regular class where they were voluntarily asked to complete them, after informing that the anonymity in the research was granted. Figure 3 summarizes the answers provided by the students based on the Liker-type test. The results of the descriptive statistics of the participants' responses ($N = 65$) are as well listed in Table 3.

As a first approach to know the dimension of this study, the students were asked about their implication in the course activities (Q1). Q1 was intended to learn whether the students were watching the video-lectures or not. Only 8 % of the students were not following the class schedule and not reviewing regularly the video-lectures provided before the class. That means that an important percentage of the sample actively participated in the proposed methodology, and therefore, the opinions provided in the study are significant to analyze the perceptions toward the flipped method followed. According to the opinions collected from the students, there was a general positive opinion about the flipped materials employed for this class (Q2–Q7). Nearly 75 % of the students agreed or strongly agreed that video-lectures helped them to learn (Q4), and the possibility of rewind and re-watch the lectures was selected for over 92 % of the participants as great help to achieve learning goals. These findings help those form previous studies endorsing that pre-class videos are building students' conceptual understanding and valuable for convenience (Imran 2013; González-Gómez et al. 2016; Long et al. 2016). On the other hand, as mentioned before, the possibility of taking out of class time lectures allowed the instructor to do more students-centered activities, such as peer discussions and other collaborative activities. This collaborative learning during face-to-face instruction is meaningful to students' cognition and retention, and constitute an important advantage of the IIM (Moraros et al. 2015). According to the students' opinions, these collaborative activities were also relevant in the learning process (Q5, 80 % agreed or strongly agreed). These findings propose that a flipped learning is useful in participating students more than is happening in their other classrooms (Roach 2014).

To make the video-lectures more appealing to students, all of them were recorded resembling in-class lectures by means of using different computer applications (González-Gómez et al. 2016). Particularly, tools such as PowerPoint slides or Doceri were used to grab the video-lectures, which have proved to be effective delivering the multimedia of science contents (Silverberg Lee et al. 2014; Fitzgerald and Li 2015). This feature was well rated by the students, since nearly 80 % of them considered that the

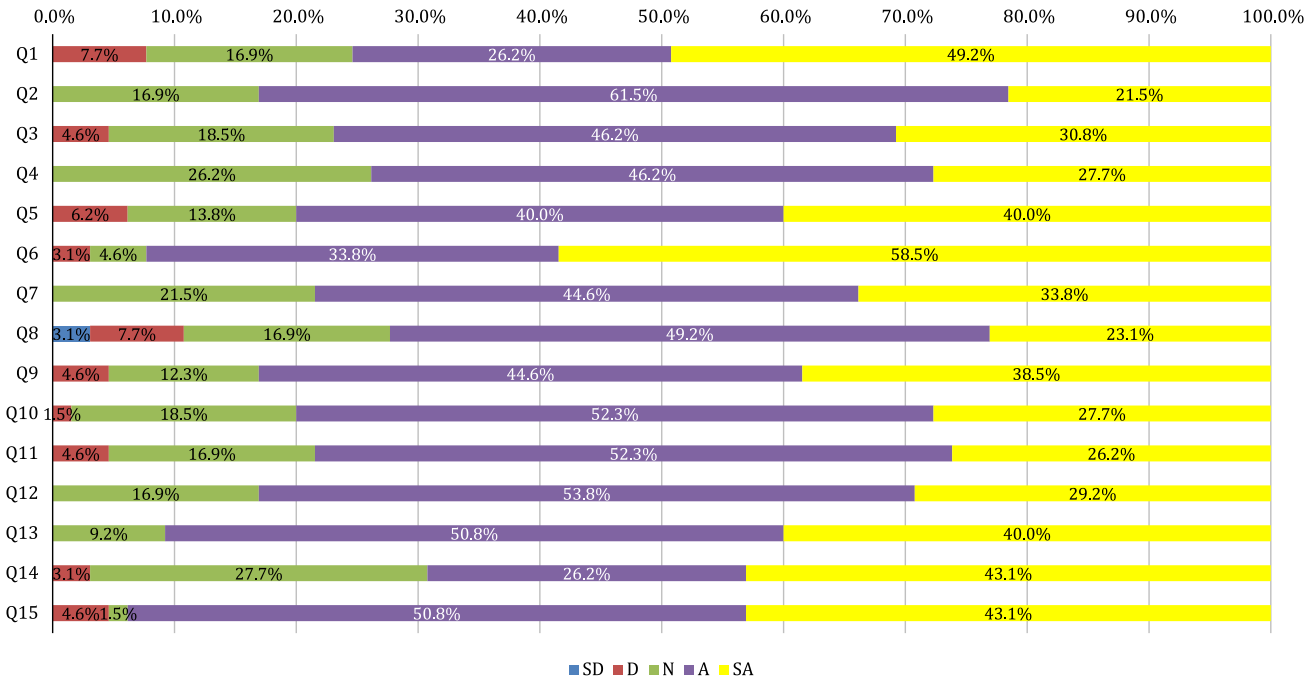

Fig. 3 Responses' analysis of Likert-type test as percentage of students' answers. Questions order is the same as listed in Table 2

Table 3 Descriptive statistics of participants' responses in the survey

Questionnaire	Frequency					Descriptive statistic	
	Strongly disagree (SD)	Disagree (D)	Neutral (N)	Agree (A)	Strongly agree (SA)	Mean	Standard deviation
Q1	0	5	11	17	32	4.17	0.98
Q2	0	0	11	40	14	4.05	0.62
Q3	0	3	12	30	20	4.03	0.83
Q4	0	0	17	30	18	4.02	0.74
Q5	0	4	9	26	26	4.14	0.88
Q6	0	2	3	22	38	4.48	0.73
Q7	0	0	14	29	22	4.12	0.74
Q8	2	5	11	32	15	3.82	0.85
Q9	0	3	8	29	25	4.17	0.82
Q10	0	1	12	34	18	4.06	0.73
Q11	0	3	11	34	17	4.00	0.79
Q12	0	0	11	35	19	4.12	0.67
Q13	0	0	6	33	26	4.31	0.64
Q14	0	2	18	17	28	4.09	0.91
Q15	0	3	1	33	28	4.32	0.73

video-lectures that resembled in-class lectures helped them to learn. These results are in the line with the observation of Roach (2014), where 78 % of the students agreed or strongly agreed with this statement. To complete this part of the test, the students were also surveyed about the quality of the flipped material provided (Q2 and Q3). Only 6 % of the participant considered that the materials were not well designed, structured or clearly-defined, and the rest of them agreed that the course was easy to follow.

Another important feature of the IIM is the possibility to deliver just-in-time lectures (Tourón and Santiago 2015) as a response of the online questionnaires taken by students and revised by the instructor right before class. That feasibility allows to blend the teaching to overcome the difficulties identified in students' answers. According to answers provided by the students, 72 % agreed or strongly agreed that the online quizzes provided right after watching the video-lectures and autonomously working the flipped material were useful to point out and overcome the most complex contents (Q8). In fact, the completion and revision of the flipped materials and online activities scheduled in the course increased the confidence of the students to overcome face-to-face in-class activities (83 % agreed or strongly agreed, Q9) and also found them more easy to complete (80 % agreed or strongly agreed, Q10).

With regard of the students' perceptions about the instruction methodology as a whole (Q11–Q15), according to their responses, the majority of the students were satisfied with the IIM and were willing to have more courses flipped (94 % agreed or strongly agreed, Q15). In fact, over 80 % of the students considered that the course was a valuable learning experience, and over 91 % thought that the course was more interactive than other courses taken in the same school (Q12 and Q13). The perceptions of the IIM were also described in Roach's research (Roach 2014).

When the students were asked to define the course in terms of keywords (see Fig. 4), the most frequent terms were related with the innovative characteristics of the course, its applicability or usability and interactive characteristics. It is also relevant to highlight that keywords such as hands-on, learnable, dynamic or motivated were also among the most mentioned by the students. This keywords frequency reveals that the students grant an important relevance to more students-centered activities carried out during the face-to-face in-class time. That type of activities is more feasible in a flipped classroom structure, where the class time is not used in lecturing but in giving students the opportunity to practice in-class what they are learning which is consistent with the constructive alignment approach (Biggs and Tang 2007). Similar studies specify that this view is general for the flipped classroom setting (Mason et al. 2013; Blair et al. 2015). Also, some authors have shown that the IIM increased students' motivation to study (Tune et al. 2013). Davies et al. (2013) advised that one area in which technology can be beneficial is granting content.

Finally, according to the students' responses, 78 % of them considered that the flipped methodology helped them to understand easily the scientific contents (Q11). In this particular test item, when analyzing the educational

Fig. 4 Frequency of keywords provided by the students to define the IIM as a whole. The bigger size of the keywords reflects their higher frequency

background, it was found that over 90 % of students who studied sciences before the university studies agreed or strongly agreed that the IIM helped them to understand the scientific contents, whereas nearly 80 % of those having a social science background agreed or strongly agreed with the same statement. These results are in the line of those reported by Sowa and Thorsen (2015) who found that students in STEM courses preferred an IIM methodology. In general, the analysis of the data recorded in this study demonstrated that the science background students showed higher interest for the IIM in this particular course (general science course). According to the descriptive statistics shown in Table 3, the mean values provided for all statements were over 4 points (agree and strongly agree range for the Likert-type scale) except for the Q8 statement.

The results explained above about the students' perceptions toward the IIM are coincident with earlier published studies, which emphasized that the IIM is mostly well received by the students (Love et al. 2013; Christiansen 2014; Kim et al. 2014; Roach 2014; Blair et al. 2015; Gilboy et al. 2015; Moraros et al. 2015). A restrictive factor of the IIM is how available is the Internet to the students because they need to access to all online materials at home and/or other places. Thus, the lack of an effective Internet connection and/or enough bandwidth could be a limiting aspect for the IIM (Chen et al. 2014).

Emotions' Evaluation

In order to evaluate what emotions of the students have when attending to a flipped course, they were asked to measure the frequency of happening by a 0–10 scale, where 0 meant the lowest frequency of occurrence and 10 was the highest frequency of occurrence. Table 4 summarizes the mean values provided for the 8 emotions assessed for the whole group, and also this table provides the emotions considering the participants gender. The overall highest scores corresponded to positive emotions. Among these emotions, the students gave the highest score to fun and enthusiasm (over 7 of 10 points), and confidence obtained the lower score among the positive emotions. On the other hand, the lower scores corresponded to negative emotions. In this case, boredom was scored with the lowest score value of 2.52 points, and concern was given as a high score value (4.91) among the negative emotions. It was relevant to highlight that emotions scores given for the negative emotions were more dispersed, with significant higher standard deviation values.

On the other hand, in order to assess the correlation between the studied emotions, a Chi-square correlation test was conducted. Results are summarized in Table 5. In this table, Chi-square values marked with one or two asterisks, which denote the presence of a significant correlation at a 0.05 or 0.01 level, respectively. According to the findings, all positive emotions had a significant positive correlation between them, the same as the negative emotions that were positively correlated. Getting into more details, confidence was negatively correlated with nervousness and fear at a 0.05 significant level, and tranquillity was also negatively correlated with nervousness, fear and concern at a 0.05 and 0.01significant level, respectively. Therefore, these findings support that the IIM contributes to achieve a significant learning (Pintrich et al. 1993) and to increase the students' commitment as active learners (Vázquez and Manassero 2007; Aydogan et al. 2015).

When the participant gender is considered, in general terms, the higher score values of negative emotions were provided by the women group, while the positive emotions scores were in the same range regardless the gender variable (see Fig. 5). Aspects such confidence, nervousness and fear were significantly different in both groups (95 % significance level). This gender influence was consistent

Table 4 Mean values of the emotion scores given for the participants in the survey

		Positive emotions				Negative emotions			
		Fun	Confidence	Enthusiasm	Tranquility	Nervousness	Concern	Boredom	Fear
Total ($N = 65$)	Mean value	7.10	6.34	7.05	6.48	4.63	4.91	2.52	4.37
	Standard deviation	1.41	1.77	1.41	2.05	3.04	2.99	2.29	3.71
Men ($N = 42$)	Mean value	7.07	6.67	7.00	6.47	4.04	4.42	2.38	3.61
	Standard deviation	1.38	1.71	1.19	2.35	3.17	2.96	2.14	3.59
Women ($N = 23$)	Mean value	7.15	5.74	7.13	6.48	5.70	5.78	2.78	5.74
	Standard deviation	1.50	1.76	1.77	1.41	2.51	2.91	2.57	3.60

Table 5 Chi-square test for the correlations between emotions (positive and negative) for all participants of the flipped classroom course

		Confidence	Enthusiasm	Tranquility	Nervousness	Concern	Boredom	Fear
Fun	χ^2	0.409**	0.630**	0.245*	−0.126	−0.050	−0.402**	−0.037
	Significance	0.001	0.000	0.046	0.311	0.689	0.001	0.769
Confidence	χ^2		0.210	0.575**	−0.284*	−0.219	−0.130	−0.241*
	Significance		0.087	0.000	0.020	0.075	0.294	0.050
Enthusiasm	χ^2			0.071	−0.069	0.006	−0.322**	−0.031
	Significance			0.569	0.580	0.959	0.008	0.805
Tranquility	χ^2				−0.346**	−0.256*	−0.167	−0.465**
	Significance				0.004	0.036	0.176	0.000
Nervousness	χ^2					0.668**	0.414**	0.762**
	Significance					0.000	0.000	0.000
Concern	χ^2						0.360**	0.620**
	Significance						0.003	0.000
Boredom	χ^2							0.281*
	Significance							0.021

** Correlation is significant at 0.01 level; * Correlation is significant at 0.05 level and N = 65

with the results reported before in different studies (Brígido et al. 2010; Borrachero et al. 2014).

Finally, the influence of the students' educational background was also taken into account to assess the students' emotions evolved in a flipped classroom setting. The students were sorted in two groups according to their educational background. In the first group, the students were with social sciences and arts background; and in the second groups, the students from science and technology background were included. Figure 6 shows participants' emotions for both groups. As in the previous results, positive emotions achieved higher scores than negative ones, regardless the students' background. The positive emotions such as fun, enthusiasm and tranquillity scored between 6 and 7, and no differences were found among both groups. In the case of confidence, it seems that the second group felt more confident. Regarding the negative emotions, the second group provided lower scores (below 4), whereas the first group gave higher scores to these negative emotions (over 5 points). In the case of boredom, both groups gave the same low value. When analyzing the comments provided by the students to justify their scores, it is remarkable that in most cases, the scores for the negative emotions were not moved by the instruction methodology followed but by their concern to pass the final exam.

Conclusions

The flipped classrooms setting was consisted in providing different materials, such as video-lectures, online questionnaires and other written documents, to be revised before the class. In-class time was therefore employed to the more students-centered activities, especially in the laboratory sessions. The instrument used to collect the information about the students' perceptions and emotions was a

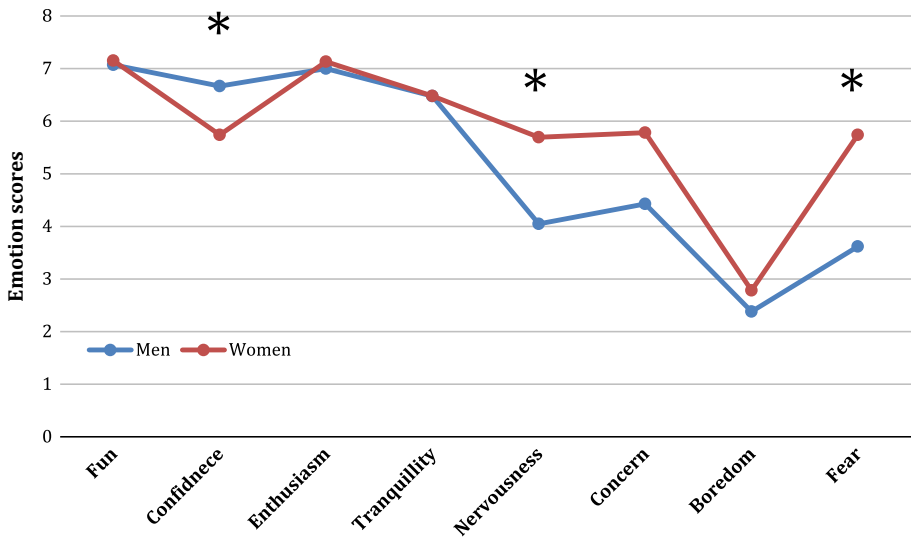

Fig. 5 Emotions toward a flipped classroom setting according to participants' gender. Emotions marked with an *asterisk* denote the existence of significant differences at a confidence level of 95 % (*t* test)

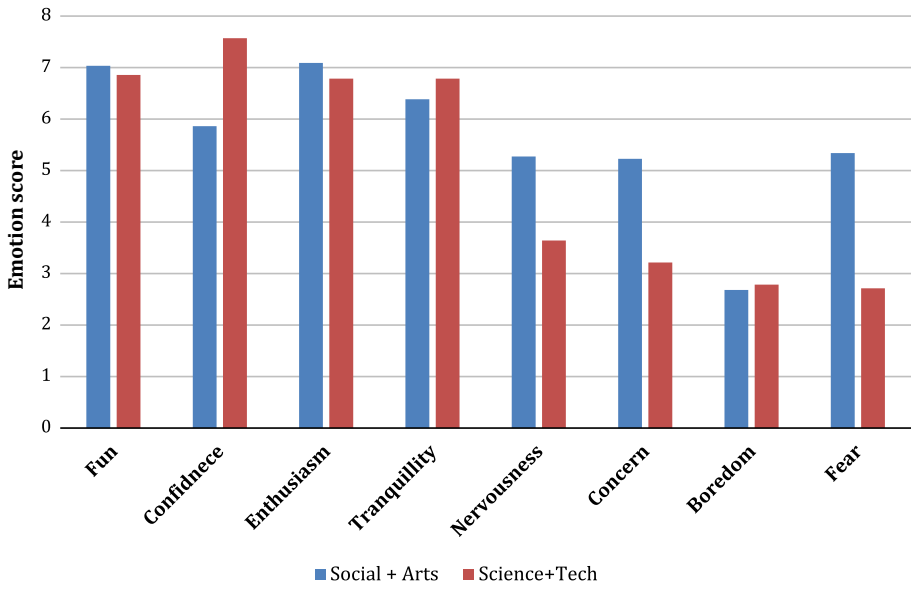

Fig. 6 Participants' emotions analysis based on their educational background

questionnaire completed by the students in the last week of the course. Precisely, the questionnaire had three sections: The first section was intended to collect general demographic information (gender, age, educational background and GPA); the second section was dedicated to survey the students' perceptions to the flipped classroom setting by means of a Likert-type test; and the third section was aimed to find out the students' emotions involved in the learning process when a flipped model was followed. In addition, a general opinion was also asked by means of keywords.

The results show that the students had a generally positive perception to a flipped classroom setting. Features as having the possibility to re-watch and rewind the video-lectures were among the most relevant highlighted by the participants. Moreover, the possibility of using in-class time to complete more collaborative and participative activities was an input of this instruction methodology. In general, the students found out this course was more interactive and were willing to have more course following a flipped model. In fact, over 80 % of the students considered that the course was a valuable learning experience and over 91 % of them thought that the course was more interactive than other courses taken in the same school. In the case of the keywords frequency map, it reveals that the students grant an important relevance to the more students-centered activities carried out during the face-to-face in-class time by using words such as "hands-on, interactive or collaborative."

According to the students' emotions toward a flipped classroom course, we have observed that the highest scores were given to the positive emotions, being fun the most

scored positive emotion. In addition, the word "fun" was among the most frequently used to define the course by means of keywords. On the other hand, negative emotions were given lower scores, especially boredom. Particularly, female students provided higher scores to negative emotions. In the Chi-square correlation test, it revealed that the positive and negative emotions were positively correlated between them. Finally, regarding the students' educational background, science and technology background provided lower scores to the negative emotions assessed in this study, while the positive scores were in the same order as social sciences and art background.

Although the results obtained in this study allow drawing a promising tendency about the students' perceptions and emotions toward the flipped classroom methodology, further research is needed to more fully contribute to the potentialities of this instruction methodology, taking into account as well, the instruction point of view.

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