COOPERATIVE LEARNING WITH WHITEBOARDING IN AN INTRODUCTORY PHYSICS COURSE

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Abstract

The aim of our study is to find out the attitude of students towards the use of cooperative learning with whiteboarding in an undergraduate introductory Physics course at the Department of Physics and Astronomy of the Faculty of Science of the University of Porto. We used an online survey and face-to-face-classroom observations as a supporting tool to collect data. The survey was based on multiple choice questions titled "Attitude Towards Cooperative Learning with Whiteboarding in Introductory Physics" (ATCLWIP), on a 5-point Likert scale, with the format *strongly disagree*, *disagree*, *undecided*, *agree* and *strongly agree*. The ATCLWIP survey was delivered via Moodle platform at the University of Porto and was validated using Cronbach alpha. Positive interdependence, individual accountability, face-to face interaction, interpersonal and small group social skills and group processing were investigated in the survey. About 100 students took part in the survey, from bachelors in Mathematics, Environmental Science and Technology, and Geology. This course combines lectures and problem-solving classes, with students organized in small groups, with one whiteboard per group. Groups make presentations of their whiteboard, discuss and answer instructor's and peers' questions. Topics of the course include physical laws underlying mechanics and waves. Given the findings from the statistical analysis of the ATCLWIP survey, it must be highlighted the academic and social skills students achieved from working cooperatively with whiteboarding. Also, on the basis of students' answers and reflections, we assert that the implementation of this strategy will contribute to increased learning, critical thinking and socialization not only in physics but also across other courses and curricula at the University.

Keywords: cooperative learning, whiteboarding, academic and social skills

1. Introduction and review of literature

Cooperative learning is an active learning and an educational pedagogical practice used to promote socialization and learning among students (Slavin, 1995; Johnson *et al.*, 2009). Cooperative learning, as a learning strategy, provides opportunities for students to develop skills in group interactions and in working with others (Carol, 1988). As emphasized by Johnson and Johnson (1989, 1999) and Johnson, Johnson and Smith (2006), cooperative learning is the instructional use of small groups so that students work together to maximize their own and each other's learning.

According to Slavin (1987), there are two major theoretical perspectives related to cooperative learning: motivational and cognitive. The motivational theories of cooperative learning emphasize the students' incentives to do academic work, focusing on reward and goal structures. On the other hand, cognitive theories emphasize the effects of working together (Slavin, 1990). One of the key elements of cooperative learning is positive interdependence, "where students perceive that their success or failure lies within their working together as a group" (Johnson *et al.*, 1986, 2008). From a motivational perspective, "cooperative goal structure creates a situation in which the only way group members can attain their personal goals is if the group is successful" (Slavin, 1990).

Instructors have the option of structuring lessons to promote cooperative, competitive, or individualistic efforts among students, as reported by Carson (1990), Johnson and Johnson (1987) in studies about *cooperative learning in the home economics classroom* and *learning together and alone: cooperative, competitive, and individualistic*. These studies have shown that cooperative learning strategy is more effective in enhancing positive students' attitudes towards the instructional experience than competitive or individualistic methodologies. In a meta-analysis of 122 studies Johnson, Maruyama, Johnson, Nelson and Skon (1981) concluded that there was strong evidence for the superiority of cooperative learning in promoting achievement over competitive and individualistic strategies. In addition, giving the findings of McKeachie (1986), students are more likely to acquire critical thinking skills and metacognitive learning strategies, in small group cooperative settings as opposed to listening to lectures.

According to Johnson and Johnson (1989, 1999), a learning goal is a desired future state of demonstrating competence or mastery in the subject area being studied and instructional activities are aimed at accomplishing goals and are conducted under a goal structure. The goal structure specifies the ways in which students will interact with each other and the instructor during the instructional session. Each goal structure has its place (Johnson *et al.*, 1989, 1999). The learning goals may be structured in order to promote cooperative attitudes among students.

In teaching-learning processes, an instructional approach to implement cooperative learning in a classroom is with whiteboarding, where small groups of students discuss their ideas about the phenomenon to be investigated (i.e. problem-solving). After discussion, groups share their ideas and problem-solving methodology with the whole class and with the instructor. Also, they answer other colleagues' and teacher's questions.

The use of whiteboards in classroom provides opportunities for students thinking to become a visible part of the learning process. Their easy cleaning allows students to fix their errors, revise their thinking, and rewrite their ideas (Muslu *et al.,* 2010). Whiteboarding is an instructional approach to help students working cooperatively, fostering their communication skills.

Henry, Henry and Riddoch (2006) suggest different ways of students' whiteboards share. *Museum walk*, where all groups put their whiteboard on a wall, as in a museum or "gallery" walk. Students walk and look at the content of the different whiteboards, having a chance to question and discuss the different whiteboards' content. In the *Circle* methodology, students make a circle and all groups hold their whiteboards, giving a chance to all students to see the whiteboard's content at the same time. This gives an opportunity to foster discussion among groups, as well. In the *Presentation* methodology, the different groups make a presentation of the content of their whiteboards. In a tutorial science class, this methodology gives students' opportunity to explain to the whole class and teacher their thinking, their graphs, their drawings, the laws and equations underlying the problem solution. Also, students answer other groups' and teacher questions. In this study we have adopted this last cooperative instructional methodology in tutorial classes of an introductory Physics course at the University of Porto, in Portugal.

According to Gillies (2007) cooperative learning involves five key elements which are crucial to improve both the social and learning processes among the participants.

"**Individual Accountability** which involves students' understanding that they will be held accountable for their individual contributions to the group, that free-loading will not be tolerated, and that everyone must contribute" (Gillies, 2007).

"**Social Skills** refer to interpersonal and small group skills such as effective communication which are needed to cooperate successfully" (Gillies, 2007).

"**Face-to-face Interaction** involves working in small groups where students can see each other and are engaged in face-to face interaction" (Gillies, 2007). This includes oral explanations of how to solve problems, discussing the concepts that are being learned. It is through face-to-face, promotive interaction that members become personally committed to each other as well as to their mutual goals.

"**Positive Interdependence** which encourages students is established when everybody understands that each member's contribution is important in helping the group to achieve its goal" (Gillies, 2007). There are many strategies to promote positive interdependence, including (Smith *et al*., 1997):

"Output goal interdependence- a single product is produced by the group".

"Learning goal interdependence- the group ensures that every member can explain the group's product".

"Resource interdependence- members are provided parts of the assignment or relevant information or the group is only provided one copy of the assignment".

"Role interdependence- members are given distinct roles that are key to the functioning of the group".

"**Group Processing** refers to the assessment of cooperative learning. It can be described as a formative assessment that focuses on students' feedback on the learning process, including the students' reflection on what they still need to do to accomplish their objectives" (Gillies, 2007).

Slavin (1996) reported that cooperative learning has been linked to the enhancement in the academic achievement of students at all ability levels. Students participating in cooperative learning exercises earn higher grades and better scores on tests for both volume and accuracy of material, long-term retention, problem-solving and higher reasoning abilities (Johnson *et al.*, 1998).

2. Purpose of the study

This study aims at probing the attitudes of students towards the use of cooperative learning with whiteboarding in an introductory physics course at the Department of Physics and Astronomy of the Faculty of Sciences of the University of Porto, in Portugal.

3. Research Methodology

3.1 Course design

The Introductory Physics course in this study was carefully developed to include a meaningful cooperative learning experience intertwined with regular instruction. Classical lecture instruction (traditional) was accompanied by cooperative learning with whiteboarding in tutorial classes. Both lecture and tutorial classes had a schedule of 2h/week, corresponding to a total of 56 contact hours, during 14 weeks.

In tutorial classes, groups of four students were assembled to work cooperatively to solve problems and answer questions about lecture's subjects. Studies revealed that the optimal group size varies from four to five (Jacob, 2006). According to Jacob (2006) four members in a group seem to be the most popular size. Some authors advocate two factors in effective group size: the students' comfort level and the nature of the assignment. Also, in these studies instructors are encouraged to use heterogeneous groups – the less academically competent students should work with the more academically competent students.

After completing their whiteboard, some groups made presentations of their contents, exposing their problem solutions, graphs, thinking and drawings, facilitating in this way whole class discussion.

3.2 Participants

Our Research Methodology was applied to the introductory physics course called Physics I, lectured at the Department of Physics and Astronomy, of the Faculty of Science, at the University of Porto, in the academic year 2018/19 (Fall 2018). Participants of this research included students enrolled in the First Degree in Chemistry, in the First Degree in Environmental Sciences and Technology, in the First Degree in Geology and in the First Degree in Mathematics. The graph in figure 1 shows the distribution of participants across different degrees. Data revealed that there was 37% of students enrolled in Chemistry, 28% in Geology, 34% in Environmental Sciences and Technology and 1% in Mathematics. The size of the population in this study was 162 students, consisting of 52% of females and 48% of males, as shown in the graph depicted in figure 2. All students were 18 years old or older.

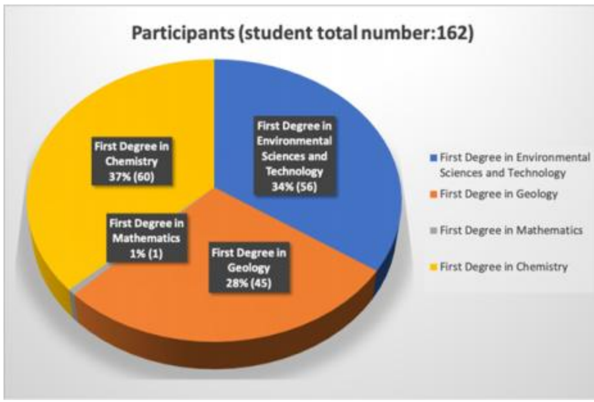

Figure 1 Participants distribution

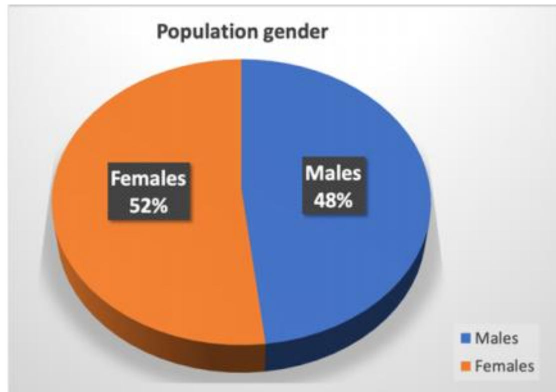

Figure 2 Population gender

3.3 Research procedure and instrument

The research procedure used in this study was a questionnaire based on multiple choice questions titled "Attitude Towards Cooperative Learning with Whiteboarding in Introductory Physics (ATCLWIP)", on a 5-point Likert scale, with the format *strongly disagree (SD)*, *disagree (D)*, *undecided (U)*, *agree (A)* and *strongly agree (SA)*. The responses, SA, A, U, D and SD were respectively assigned value point of +2, +1, 0, -1, -2. This questionnaire was adapted from the "Students Attitudes toward Group Environments", (SAGE) survey, developed by the Centre for the Study of Learning and Performance in Quebec, Canada (Duckworth, 2010).

The ATCLWIP questionnaire consists of 28 Multiple Choice Questions (MCQ) on 5 rating scale responses, 5 extended answer questions and 2 multiple choice questions on demographic and general information. The Multiple Choice Questions were divided into four subscales (Duckworth, 2010): (1) Quality of Product and Process: "the perceived academic benefits of working with other students" (Kouros *et al.*, 2006); (2) Peer Support: "the personal support students give and receive when working in groups" (Kouros *et al.*, 2006); (3) Student Interdependence: "the degree to which students contribute to the group process and product, there is equal participation, and evaluation depends on the grade of others members" (Kouros *et al.*, 2006); (4) Frustration with Group Members: "the frustration experienced when working with less academically competent members, disliking the assigned group members, and want to work with friends" (Kouros *et al.*, 2006). The extended answer questions allowed students to share their thoughts regarding cooperative learning with whiteboarding.

The online ATCLWIP questionnaire was distributed to students using Moodle platform at the University of Porto and was validated using Cronbach alpha. The obtained Cronbach's alphas were 0.71 for subscale 1, 0.79 for subscale 2, 0.70 for subscale 3, and 0.30 for subscale 4. A Cronbach alpha of 0.70 is generally considered acceptable.

4. Data Analysis

The data of ATCLWIP survey were grouped and analyzed, using Excel, as the overall sample and in the above mentioned four subscales. The mean and standard deviation (STD) for the overall sample were calculated for each item. Percentages of disagreement, undecided and agreement were also calculated. The percentage of agreement was determined by adding the percentages of SA and A. The percentage of disagreement was obtained by adding the percentages of SD and D. Mean and standard deviation (STD) and percentages for the four subscales were also calculated.

4.1 Research Findings

Table 1 shows the mean and standard deviation (STD) for overall sample, together with percentages of agreement, undecided and disagreement.

Table 1 Mean and standard deviation for the overall sample. Questionnaire adapted from the "Students Attitudes toward Group Environments", (SAGE) survey, developed by the Centre for the Study of Learning and Performance in Quebec, Canada (Duckworth, 2010)

Mean and Standard Deviations for the Overall Sample

Item	Subscale	Item Stem	MEAN	STD	A+SA	U	D+SD
1	1	The problem solving classes with student groups allow a better understanding of the subjects than traditional classes.	0,88	0,90	71,4	22,4	6,1
2	1	The material is more interesting to me when I work with other students.	0,86	0,84	79,6	12,2	8,2
3	1	My work is better organized when I work in a group.	0,14	0,91	38,8	34,7	26,5
4	3	*I do not care if group members get good grades.	0,20	1,34	44,9	24,5	30,6
5	4	When I work in groups I want to be with my friends.	0,67	0,92	71,4	14,3	14,3
6	2	*My group members do not respect my opinion.	1,45	0,58	95,9	4,1	0,0
7	2	*My group members make me feel that I am not as smart as they are.	1,49	0,79	85,7	12,2	2,0
8	3	I become friendly with my group members.	1,22	0,69	89,8	8,2	2,0
9	4	When I work in a group, I am able to share my ideas.	1,10	0,77	85,7	12,2	2,0
10	2	*I find it hard to express my thoughts when I work in a group.	0,63	0,93	67,3	18,4	14,3
11	1	My group members like to help me learn the material.	0,84	0,72	79,6	16,3	4,1
12	2	I feel I am part of what is going on in the group.	1,02	0,92	87,8	4,1	8,2
13	3	Our job is not done until everyone has finished the assignment.	0,49	1,00	51,0	32,7	16,3
14	3	I learn to work with students who are different from me.	0,84	0,72	75,5	22,4	2,0
15	4	*I do not like the students I am assigned to work with.	1,47	0,68	89,8	10,2	0,0
16	3	I get to know my group members well.	0,65	1,09	65,3	20,4	14,3
17	2	When I work in a group, there are opportunities to express my opinions.	0,88	0,83	79,6	16,3	4,1
18	3	We can not complete the assignment unless everyone contributes.	0,10	1,08	36,7	32,7	30,6
19	2	*My group members do not like me.	1,24	0,85	81,6	14,3	4,1
20	3	I help my group members with what I am good at.	1,22	0,69	89,8	8,2	2,0
21	4	*I have to work with other students who are not as smart as I am.	0,51	1,17	49,0	24,5	26,5
22	4	*Some group members forget to do the work.	0,29	1,06	44,9	30,6	24,5
23	3	It is important to me that my group gets the work done on time.	0,67	0,94	69,4	16,3	14,3
24	4	*I am forced to work with students I do not like.	1,35	0,75	87,8	10,2	2,0
25	4	*When I work with other students we spend too much time talking about other things.	0,02	0,75	26,5	51,0	22,4
26	3	I also learn when I teach the material to my group members.	1,12	0,93	77,6	18,4	4,1
27	3	Everyone's ideas are needed if we are going to be successful.	1,08	0,73	85,7	10,2	4,1
28	4	*I prefer to choose the students I work with.	-0,57	0,96	10,2	38,8	51,0

* Items negatively worded on the questionnaire. Reverse coded for all analyses.

Data from subscale 1, Quality of Product and Process, shown in table 2, indicates that the highest percentage of agreement was 79.6%. These students felt that "The material is more interesting to me when I work with other students" and "My group members like to help me learn the material". A high percentage of students, over 70%, also felt that "The problem-solving classes with student groups allow a better understanding of the subjects than traditional classes."

Table 2 Subscale 1, Quality of Product and Process

Subscale 1 - Quality of Product and Process for the Overall Sample

Item	Item Stem	MEAN	STD	A+SA	U	D+SD
1	The problem solving classes with student groups allow a better understanding of the subjects than traditional classes.	0,88	0,90	71,4	22,4	6,1
2	The material is more interesting to me when I work with other students.	0,86	0,84	79,6	12,2	8,2
3	My work is better organized when I work in a group.	0,14	0,91	38,8	34,7	26,5
11	My group members like to help me learn the material.	0,84	0,72	79,6	16,3	4,1

Note: A+SA = Agree + Strongly Agree; U = Undecided; D+SD = Disagree + Strongly Disagree.
*Items negatively worded on the questionnaire. Reverse coded for all analyses.

In the data from subscale 2, Peer Support, shown in Table 3, four out of the six items had higher than 80% agreement, "My group members do not respect my opinion", "My group members make me feel that I am not as smart as they are", "I feel I am part of what is going on in the group", "My group members do not like me". Items negatively worded (*, see table 2) on the questionnaire, were reverse coded for all analyses. In negative statements an answer of Disagree (D) or Strongly Disagree (SD) means a positive attitude towards cooperative learning.

Table 3 Subscale 2, Peer Support

Subscale 2 - Peer Support for the Overall Sample

Item	Item Stem	MEAN	STD	A+SA	U	D+SD
6	*My group members do not respect my opinion.	1,45	0,58	95,9	4,1	0,0
7	*My group members make me feel that I am not as smart as they are.	1,49	0,79	85,7	12,2	2,0
10	*I find it hard to express my thoughts when I work in a group.	0,63	0,93	67,3	18,4	14,3
12	I feel I am part of what is going on in the group.	1,02	0,92	87,8	4,1	8,2
17	When I work in a group, there are opportunities to express my opinions.	0,88	0,83	79,6	16,3	4,1
19	*My group members do not like me.	1,24	0,85	81,6	14,3	4,1

Note: A+SA = Agree + Strongly Agree; U = Undecided; D+SD = Disagree + Strongly Disagree.
*Items negatively worded on the questionnaire. Reverse coded for all analyses.

In the data from subscale 3, Student Interdependence, shown in Table 4, 89.8% of students stated that "I become friendly with my group members" and "I help my group members with what I am good at". 85.7% of students felt that "Everyone's ideas are needed if we are going to be successful".

For subscale 4, Frustration with Group Members, shown in Table 5, 89.8% students stated that "I like the students I am assigned to work with.". This is again an item negatively worded on the questionnaire, so it was reverse coded for analysis.

To check the reliability of the overall sample and the four subscales, we calculated the corresponding Cronbach's alpha, which is presented in table 6. For a reliable scale, a Cronbach's alpha of 0.7 is generally accepted. The values of the Cronbach's alpha for subscales 1, 2 and 3 range from 0.70 to 0.79, which means that these subscales are reliable. On the other hand, the subscale 4 (Frustration with Group Members) has a low value of the Cronbach's alpha (0.3), which means that this subscale is not reliable. We still need to understand why this happens. However, from extended answers we came to know that not all teachers used the methodology as initially recommended and it is possible that this leaded to students' frustration.

Table 4 Subscale 3, Student Interdependence

Subscale 3 - Student Interdependence for the Overall Sample

Item	Item Stem	MEAN	STD	A+SA	U	D+SD
4	*I do not care if group members get good grades.	0,20	1,34	44,90	24,49	30,61
8	I become friendly with my group members.	1,22	0,69	89,80	8,16	2,04
13	Our job is not done until everyone has finished the assignment.	0,49	1,00	51,02	32,65	16,33
14	I learn to work with students who are different from me.	0,84	0,72	75,51	22,45	2,04
16	I get to know my group members well.	0,65	1,09	65,31	20,41	14,29
18	We can not complete the assignment unless everyone contributes.	0,10	1,08	36,73	32,65	30,61
20	I help my group members with what I am good at.	1,22	0,69	89,80	8,16	2,04
23	It is important to me that my group gets the work done on time.	0,67	0,94	69,39	16,33	14,29
26	I also learn when I teach the material to my group members.	1,12	0,93	77,55	18,37	4,08
27	Everyone's ideas are needed if we are going to be successful.	1,08	0,73	85,71	10,20	4,08

Note: A+SA = Agree + Strongly Agree; U = Undecided; D+SD = Disagree + Strongly Disagree.
*Items negatively worded on the questionnaire. Reverse coded for all analyses.

Table 5 Subscale 4, Frustration with Group Members

Subscale 4 - Frustration with Group Member for the Overall Sample

Item	Item Stem	MEAN	STD	A+SA	U	D+SD
5	When I work in groups I want to be with my friends.	0,67	0,92	71,43	14,29	14,29
9	When I work in a group, I am able to share my ideas.	1,10	0,77	85,71	12,24	2,04
15	*I do not like the students I am assigned to work with.	1,47	0,68	89,80	10,20	0,00
21	*I have to work with other students who are not as smart as I am.	0,51	1,17	48,98	24,49	26,53
22	*Some group members forget to do the work.	0,29	1,06	44,90	30,61	24,49
24	*I am forced to work with students I do not like.	1,35	0,75	87,76	10,20	2,04
25	*When I work with other students we spend too much time talking about other things.	0,02	0,75	26,53	51,02	22,45
28	*I prefer to choose the students I work with.	-0,57	0,96	10,20	38,78	51,02

Note: A+SA = Agree + Strongly Agree; U = Undecided; D+SD = Disagree + Strongly Disagree.
*Items negatively worded on the questionnaire. Reverse coded for all analyses.

Table 6 Mean, Standard Deviation and Cronbach Alpha for the four subscales

	Subscale	MEAN	STD	ALPHA
1	Quality of Product and Process	0,68	0,84	0,71
2	Peer Support	1,12	0,82	0,79
3	Student Interdependence	0,76	0,92	0,70
4	Frustration with Group Members	0,60	0,88	0,30

Extended answer questions are shown in Table 7. From these answers it should be emphasized that as the highest advantages of solving problems in group, students stated "exchange ideas" and "discussion". As highest disadvantages, students stated "distractions" and "too much conversation". As highest advantages of using a whiteboard for problem-solving in a group, students stated "helps teacher to correct errors" and "more dynamic classes". As highest disadvantages, students stated "teacher may have difficulty in assisting all groups" and "may cause stress in solving difficult problems". In students' suggestions to improve group work with whiteboards during problem-solving classes, it was stated that "decrease the number of students per class for better assistance" and "teacher should also participate in problem-solving".

Table 7 Extended answer questions

Mention 3 advantages of solving problems in a group.	Mention 3 disadvantages of solving problems in a group.	Mention 3 advantages of using a whiteboard for problem solving in a group.	Mention 3 disadvantages of using a whiteboard for problem solving in a group.	If you have any suggestion to improve group work with whiteboards during problem solving classes, please mention it.
Exchange of ideas	Distractions	Helps teacher to correct errors	Teacher may have difficulty in assisting all groups	Decrease the number of students per class for better teacher assistance
Discussion	Too much conversation	More dynamic classes	May cause stress in solving difficult problems	Teacher should also participate in problem
Better environment to expose ideas	Conversation on subjects outside the course	Better understanding of reasoning in problem solving	Leads to more noise.	
Better understanding of subjects	Noise makes concentration difficult	Easier exposition of ideas	Difficult to conciliate with notebook writing	
Different ways of solving problems	Students may have different rhythms to solve problems	Easier student interaction		
Faster problem soving	Not all students work as required	Better visibility		
Work more natural and fun	Consensus may be more difficult and lengthy	Better comparision of different solving strategies		
There is more interest in working		Allows watching other group's work		
Mutual aid				
Time runs faster				
More communication				
Learning to work in a group				
Socialization and integration				

4.2 Recommendations

Based on the findings of this study on cooperative learning with whiteboarding in an introductory physics course, the following recommendations were made:

i) cooperative learning with whiteboarding instruction approach is an effective methodology to enhance students' learning and academic achievement in introductory Physics

ii) cooperative learning with whiteboarding instruction methodology could be adopted not only in introductory Physics courses, but could be extended to Biology, Chemistry, Geology, Geophysics, Mathematics and other subject classes settings, helping to enhance students' attitude towards the subject.

iii) training and workshops should be organized to create awareness and techniques required to implement cooperative learning with whiteboarding at the University of Porto.

5. Discussion and Conclusion

We found several advantages for conducting tutorial classes in an introductory physics course using as instructional methodology cooperative learning with whiteboarding. Students benefited in many ways: **i)** cooperative learning with whiteboarding created an atmosphere in the class setting where students constructed their own understanding and evidence-based knowledge: before writing on the whiteboard, students discussed their ideas and constructed a group consensus; **ii)** since students worked together, whiteboarding provided opportunities for collaboration and peer learning, through which all students could took an active role in the learning process; **iii)** groups made presentations of their whiteboards, displayed their whiteboards and explained their thinking, drawings, graphs and answered

teachers' and other groups' questions. While sharing their whiteboards, all students had an opportunity to voice their ideas, to link concepts and saw the relationships between ideas, which fostered dialogue not only within, but also across groups.
However, students reported some disadvantages to the whiteboarding instruction: **i)** the fear to be wrong and **ii)** standing in front of the classroom. Yet it was made clear, by the instructors, that mistakes were expected to happen and we all learn from mistakes, which helped to relieve some student anxiety.
The instructor's role was that of facilitator. As students whiteboarded their solutions/ideas, the teacher could recognize flaws in understanding, diagnosed areas of student difficulty and identified misconceptions. To sum up, teacher could get a sense of students' strengths and weaknesses.
It should be emphasized that the design of these whiteboarding class settings in this study fostered face to face interactions, both students to students and students to teacher, with the instructional methodology promoting a student-centered learning, where the students were responsible for their construction of knowledge (Duckworth, 2010). This fosters the level of students' engagement in learning activities, critical thinking skills and a positive relationship among students. This active involvement of students could be one of the best predictors of learning and students' academic achievement. When students are successful they view the subject matter with a very positive attitude because their self-esteem is enhanced, which in turn leads to a reinforced interest in the subject and higher performance.

Positive interdependence, individual accountability, face-to face interaction, interpersonal and small group social skills and group processing were investigated in the ATCLWIP questionnaire. The findings revealed that cooperative learning with whiteboarding strategy can be adopted as an effective learning strategy to enhance students' attitudes towards the physics subject. The cooperative learning strategy could be used in teaching other subjects at the University, i.e., Biology, Chemistry, Geology, Mathematics, etc.

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Biography

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