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The Conceptual Change through Hybrid Evaluation among High School Students in Life and Earth Sciences

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Abstract: According to the literature, conceptual change is a primary challenge in science education. Several studies have indicated that learners use their intuitive conceptions even after science instruction. Therefore, our study aimed to create working conditions that would support learners' achievement of conceptual change. We hypothesized that integrating learners into the teaching-learning process in a collaborative setting will positively impact their performance to reflect the degree to which they achieve conceptual change. After the realization of a course respecting the official instructions and the curriculum of life and earth sciences, we proposed to the students of a public high school to pass a hybrid evaluation of this subject where we asked them to realize collaboratively in small groups, presentations of the synthesis of the course that they had received, in the form of a video capsule. This method has already been approached in other research works. The difference in this work is that the student's presentation was asynchronous, leaving the student the right to make mistakes and self-correction. A written evaluation in class completed this work to verify the achievement of the conceptual change in them. The analysis of the student's results in the hybrid evaluation and their comparison with the results they obtained in the first semester showed a considerable improvement in the level of the students, especially for those who had an average or even weak mastery according to the marks obtained in Life and Earth Sciences during the first semester. The collaborative work in small groups was an opportunity for exchange, sharing, and mutual help among the students, who were more motivated and showed great interest in this method.

Keywords: hybrid evaluation, conceptual change, life and earth sciences, high school, collaborative learning.

生命與地球科學高中生混合評價的觀念轉變

摘要：根據文獻，概念改變是科學教育的主要挑戰。一些研究表明，即使在科學教學之後，學習者也會使用他們的直覺概念。因此，我們的研究旨在創造支持學習者實現概念轉變的工作條件。我們假設，將學習者融入協作環境中的教學過程將對他們的表現產生積極影

響，以反映他們實現概念轉變的程度。在完成一門尊重官方指導和生命與地球科學課程的課程後，我們向一所公立高中的學生提議通過該科目的混合評估，我們要求他們以小組形式合作實現，展示 他們以視頻膠囊的形式綜合了他們所接受的課程。這種方法已經在其他研究工作中得到應用。這項工作的不同之處在於學生的陳述是異步的，讓學生有犯錯和自我糾正的權利。課堂上的書面評價完成了這項工作，以驗證他們在觀念轉變方面的成就。通過對學生在混合測評中成績的分析，與第一學期的成績對比，可以看出學生的水平有了相當大的提高，尤其是對於第一學期成績掌握一般甚至較弱的學生。第一學期的生命與地球科學。小組協作為同學們提供了交流、分享、互助的機會，同學們的學習積極性更高，對這種方式表現出了濃厚的興趣。

关键词：混合評估、概念改變、生命與地球科學、高中、協作學習。

1. Introduction

The evaluation has always played a fundamental role in measuring the quality of service or product and the effectiveness of a system, in any field. In the learning process, it presents a major pillar since it allows us to gather information in relation to the acquisition of concepts by the learners and to interpret them to make a judgment and an ideal decision on the quality and level of learning [19], because we cannot quantify or qualify the quality of this process, only through a reliable, objective and valid evaluation.

The spread of the COVID-19 pandemic caused major changes in the educational system, which had to move to a distance learning mode to ensure pedagogical continuity and completion of the school and university curriculum. This difficult but important experience revealed that many countries, including Morocco, were not ready to move to this mode of education so quickly; moreover, several issues would need to be developed to make their educational system fit for all circumstances, mainly evaluation, which posed several questions during this critical period.

Following the health crisis, thought had to be given to a distance evaluation consisting of many reflections identical to those relating to an in-person evaluation to find the best combination according to the possibilities and constraints [25], an evaluation that will use different degrees of integration of ICT and web tools [18], even though distance evaluation modes present a major pedagogical challenge [20].

1.1. Context of the Work

In the Moroccan context, distance learning evaluation was an almost impossible mission for some age groups, mainly primary and secondary, due to several socio-economic factors, namely that a high percentage of learners came from modest families that could not afford the digital tools necessary for distance learning and evaluation; in the same family. Often there was more than one child who had to follow their distance learning at the same time with the same digital tool that lead to the lack of privacy [15].

This prompted the Moroccan government to suspend the certification exams as well as the continuous evaluation provided during this period for these age groups and to consider only the evaluations done before the confinement; this made the first year of the COVID-19 pandemic crisis a period without evaluation in the Moroccan school system.

During the second year of the COVID-19 crisis, the Moroccan government adopted a hybrid mode of teaching; where half of the learning was done in class in the presence of teachers. The rest was done at a distance, where learners faced a self-learning through the didactic support proposed by the Ministry of National Education (PDF courses, video capsules). Even in these conditions; teachers found it difficult to establish distance evaluations reflecting the real degree of mastery of the skills expected by the apprenticeship, as well as the degree of realization of the conceptual change in the learners.

Learning today has returned to the way it was before, in the classroom, as the pandemic situation has begun to stabilize. Except that we are not sure that there will not be other circumstances that will influence the educational system again and require its return to the distance learning mode. Will we be able to meet the challenge and confront the difficulties that have interrupted the effective unfolding of the learning and evaluation processes during this period?

However, the experience of distance learning has shown several advantages such as flexibility in time, diversity of digital resources in support of learning, recording and easy return to the information, familiarization with digital tools [12], which can be exploited to accompany learning.

1.2. Problematics

According to the literature, even under normal working conditions, conceptual change presents a major challenge to science didactics [9] because usually the learner comes to the classroom with already constituted empirical conceptions [1], which he/she accumulates from his/her own experience and environment, these often erroneous ones oppose this process and present obstacles in the face of the acquisition of scientific conceptions [4], as learners often retain and refer to their initial conceptions even after a lecture [5] especially when the context is changed or when enough time is allowed between the teaching moment and the evaluation [27], leading to a different way of looking at science teaching, requiring the successful production of conceptual change [8].

This is why we have assumed that to achieve a conceptual change in learners, it will be necessary to involve them in the teaching and evaluation process through collaborative learning; on the one hand to motivate them, knowing that there is a reciprocal relationship between motivation and the success of the teaching-learning process [21], and on the other hand to create a favorable climate of cooperation aimed at improving learning quality.

What impact will the involvement of learners in the collaborative learning process, through a hybrid evaluation, have on their performance and on the achievement of a conceptual change in them?

1.3. Objectives

Several previous works have talked about the importance of social interactions in the teaching-learning process [14], as well as the positive effect of collaborative work on students' motivation and performance. However, learners often negatively view assessment, especially because it is mostly reduced to exams and confused with grading, which leads to a bad reputation and arouses distrust or even anxiety in them [7]. Therefore, we assumed that integrating learners into the assessment process, in a collaborative context, will likely have a positive impact on their motivation and their performance. In this work, we set the goal to measure the impact of learners' involvement, in the form of small groups, in the assessment process on their performance in Life and Earth Sciences (LES), which will reflect the degree of conceptual change realization in them.

Therefore, we took as a criterion the results of the students after their integration in the evaluation process compared with the results they obtained in the first semester of the same school year using the classic evaluation method.

2. Methodology

Before its realization, this learning situation was presented to a group of experts composed of a pedagogical inspector in Life and Earth Sciences, a trainer at the regional center of education and training Casablanca, the provincial director of the Ministry of National Education of the region of Hay Hassani Casablanca and a secondary school teacher qualifying in Life and Earth Sciences, who gave their remarks and suggestions regarding the learning situation. This one was adjusted before its validation by this group of experts.

2.1. The Sample Being Studied

In a population of eighty students of scientific common trunk, International Baccalaureate French Option, belonging to a public high school "Khadija Oum Almouminin" divided into two classes; we chose to work with a sample of thirty-nine students (n = 39) of the same class, that is to say 48.75% of the population; where we asked them to divide themselves into small groups of two to four students according to their own criteria namely: mastery of the course, mastery of the computer tool, skills in relation to the assembly, approximation of the habitats.

The students, under the guidance of their teacher, were aware that the choice of the group should not be random and that they should have complementary skills to be able to succeed in this experiment; this allowed us to obtain thirteen groups.

2.2. Measurement Tools

To supervise the work of the students of the sample studied, the teacher gathered them in a one-hour training session; where he explained to them the guidelines to follow, in relation to the content they had to present, as well as instructions on the use of the digital tool; such as, the use of the editing software and the use of the camera.

After the students attended fifteen hours of class plus application exercises spread over five weeks of work, concerning the chapter: "Flow of matter and energy in an ecosystem," we proposed to them to pass a hybrid summative evaluation, where they were invited to prepare a synthesis presentation of the course they received, in the form of asynchronous video clips, not exceeding fifteen minutes, one week before the synchronous written evaluation in class.

We chose this course because of its importance in the LES core curriculum since it represents an extension of a chapter they have already studied in secondary school, as well and its continuity that will be extended over the next two years.

50% of the grade was dedicated to the written evaluation and to encourage students to give the best possible version, we dedicated 50% of the remaining grade to the asynchronous presentation that they will present as a group; especially since the mark is an extrinsic motivational tool for students [3].

Evaluating an oral presentation is a delicate task

[13], as other criteria related to the quality of the medium as well as oral communication skills will need to be considered in addition to the clarity of the presentation [6]. Therefore, to ensure a level playing field, we developed a rubric with relevant criteria that we considered to judge the quality of the presentations.

To involve the students in our sample in the evaluation process, we invited them to participate in the choice of criteria before preparing their presentation; this way, they will be able to self-evaluate since they will have a clear idea of what they should develop to succeed in their work, namely, that self-evaluation represents a primordial skill that can only be acquired by involving the learner gradually in the process [10] (Table 1).

Additionally, a survey and interviews were conducted in the classroom near the end of the experiment to measure the degree of student satisfaction with the method. Where we asked them, how satisfied they were with the experience, and if they were willing to go through it again in the following evaluations, as well as the added value of this method compared to the classical method adopted in the first semester.

Table 1 Evaluation criteria for the asynchronous presentation

Evaluation Criteria	Scale
Content validity	2 points
Clarity of content	1 point and a half
Oral expression	1 point and a half
Respect of time	1 point and a half
Evolution of the student in relation to the initial state	1 point and a half
Innovation and didactic tools used	2 points

2.3. Rationale for the Choice

We chose this hybrid evaluation method; on the one hand, because it will encourage exchange and interaction between students in the same group, during the preparation of the presentation, which will create a climate of sharing, mutual aid and sometimes cognitive conflicts that may lead to a conceptual change in the students. However, this method will allow mobilizing the whole class, since we insisted on the fact that the members of the group must intervene equitably in the video, and like that, the shy students, those who have gaps or even the disinterested ones will have the chance to express themselves. Indeed, according to [2], working in small cooperative groups provides opportunities for more reserved students to speak up by reducing exposure to others.

It is said that the best way to learn is to teach, and the students in our sample were faced with a learning situation through teaching, since we asked them to present a course synthesis video, in other words, to re-explain what they had understood from the course, which will promote their acquisition of scientific concepts.

Additionally, we have chosen the asynchronous mode, to manage the anxiety of the students and the stress generated by the synchronous presentation, to give the students the right to make mistakes and self-correction, so that the students make a self-criticism of their own presentation and only hand in their work when they are convinced of the final result; this way, they will be involved in the evaluation process.

Finally, this method considers the evolution of each student compared to the initial state, since the teacher has already spent a semester with his or her students and already knows the level of each one, contrary to the numerical result that only considers the final performance [32], and ranks the student in relation to the other students in the class; because finally, it is the learning of each student that is at the center and not the common product [28].

3. Results and Discussion

After the students received their course in class, they were asked to produce video vignettes in which they were to explain, in small groups, the course they had received on their own way, thus leaving room for innovation.

The work was to be completed in one week before the summative evaluation that the students took in class, so that the making of the video would be an opportunity to prepare well for the summative evaluation, especially since to explain the course in a video, the students would necessarily go through the "social-learning" collaborative learning and understanding phase.

This would lead, according to the literature, to a better long-term retention of knowledge [24], in addition to promoting the disappearance of misconceptions [11]; thus touching other aspects, which the traditional evaluation does not touch, namely: speaking, defending ideas and argumentation, cognitive conflict between students in the group and destabilization of misconceptions, to reach the conceptual change phase.

To measure the impact of this method on the students' performance, we took as a reference the results they obtained in the first semester; where we compared the results of the hybrid evaluation, of the first continuous control of the second semester, to the average of the two summative evaluations (continuous controls) carried out in the first semester in Life and Earth Sciences, of the same school year, for each student.

According to the statistics, 23% of the students obtained a grade lower than 10/20 as an average of the two summative assessments in Life and Earth Sciences in the first semester. In the hybrid evaluation (1st continuous evaluation of the 2nd semester), this percentage decreased to 18%, without considering the mark of the asynchronous presentation, and to 0% taking it into consideration.

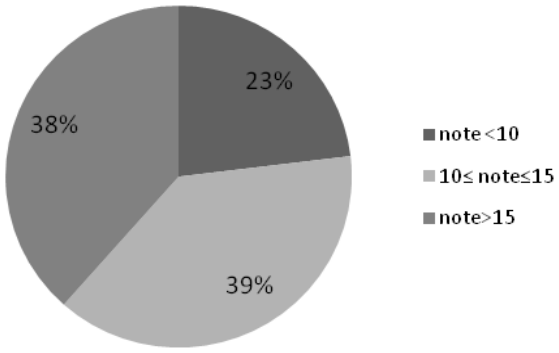

Fig. 1 Average of the two continuous evaluations in Life and Earth Sciences in the first semester

The percentage of students who obtained marks between 10/20 and 15/20 remained almost stable, but the percentage of students who obtained a mark higher than 15/20 increased from 38% in the first semester to 46% in the hybrid evaluation without considering the mark of the presentation and to 62% taking it into consideration. This shows a significant improvement in student performance on the hybrid assessment compared to the average of the two summative assessments completed in the first semester.

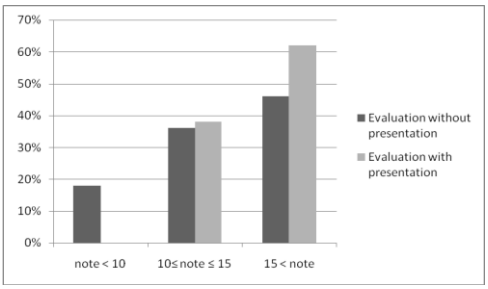

Fig. 2 Hybrid evaluation results with and without consideration of the asynchronous presentation score

To better observe the impact of this method on student performance, we subdivided our sample into three groups based on the average of the two evaluations established in LES in the first semester, as shown below.

Table 2 Ranking of students according to the average of the two tests completed in LES in the first semester

Groups	Features	Note
A	Students with good mastery	More than 15/20
B	Students with average mastery	Between 10/20 and 15/20
C	Students with gaps	Less than 10/20

Table 3 Comparison of notes in different periods between groups A, B, and C

Score of matched samples					
Groups	**Period**	**Average (out of 20)**	**N**	**Variance**	**Standard deviation**
Group A	1st semester average	18	15	2,27464952	1,50819413
(A, n1 = 15)	Hybrid evaluation without presentation	18.33	15	3,77380952	1,94262954
	Hybrid evaluation with presentation	19.02	15	1,45059524	1,20440659
Group B	1st semester average	12.69	15	2,94384	1,71576222
(B, n2 = 15)	Hybrid evaluation without presentation	13.65	15	8,17678571	2,85950795
	Hybrid evaluation with presentation	15.61	15	3,71309524	1,92693934
Group C	1st semester average	7.81	9	3,75031944	1,93657415
(C, n3 = 9)	Hybrid evaluation without presentation	9.78	9	7,31944444	2,70544718
	Hybrid evaluation with presentation	13.06	9	2,84027778	1,68531237

Subsequently, we compared the evolution of the notes in the three groups, in relation to the average obtained in the first semester (Table 3). The results obtained are presented as follows:

For group A, there was a slight evolution in the students' performance compared to the classic evaluation method. The average of this group went from 18/20 (Standard deviation = 1.50819413) in the first semester, to 18.33/20 in the hybrid evaluation, without considering the mark of the asynchronous presentation, and to 19. 02/20 (Standard deviation = 1.20440659) taking it into consideration; this does not allow us to see concretely the impact of this method on this group of students, from a grading viewpoint of view because it does not provide detailed and precise feedback since it combines various very disparate results and learning [31]. Yet, in the presentation another side of each student's personality came to light, one that is difficult to observe under conventional assessment conditions. The videos showed that after the 10 to 15 min of presentation, there was much commitment, mobilization of the students and real group work.

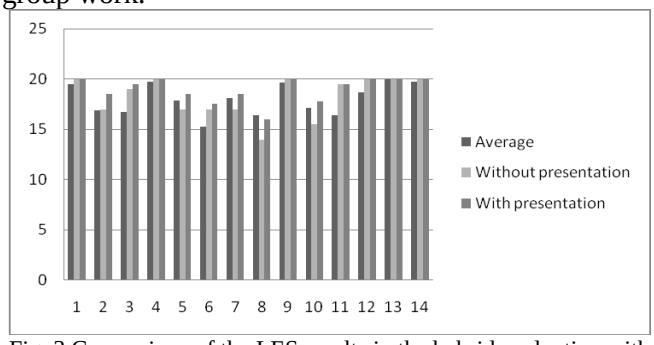

Fig. 3 Comparison of the LES results in the hybrid evaluation with the average of the two controls established in the first semester for group A

For group B, a considerable change was recorded for most of the subjects in this sample compared to their averages in LES in the first semester. The average of this group increased from 12.69/20 in the first semester to 13.65/20 in the hybrid evaluation without considering into account the mark of the asynchronous presentation, and to 15.61/20 taking it into account;

which shows the positive impact of this method on student achievement and confirms findings of [17] that engagement in collaborative learning leads learners to higher levels of knowledge acquisition and learning.

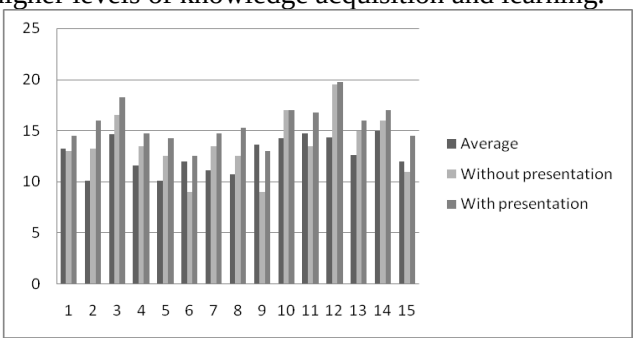

Fig. 4 Comparison of the LES results in the hybrid evaluation with the average of the two controls established in the first semester for group B

For group C, the impact of this method on the motivation of the students in this group and on the results they obtained was very significant. Even the most reserved students and those who had difficulty learning life and earth sciences were engaged in the work and made a considerable effort to understand the course and present the best version possible. The asynchronous mode was an opportunity for them to review their presentations, discuss ideas that were not yet clear, critique the work and redo the parts they were not completely convinced of; thus developing the skill of self-assessment that is not really developed in a traditional assessment. This created favorable conditions for conceptual change to occur. The results reflected this, where a remarkable change in marks was recorded in most subjects in this sample. The average of this group in LES went from 7.81/20 (standard deviation = 1.93657415) in the first semester to 9.78/20 in the hybrid evaluation without considering the grade of the presentation and to 13.06/20 (Standard deviation = 1.68531237) taking it into consideration, which proves the significant positive effect of collaborative learning on learners' interest in science [26], as well as the influence of motivation on success percentages, especially for weaker students [30].

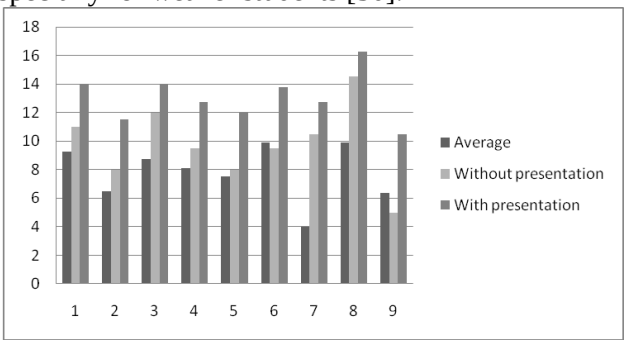

Fig. 5 Comparison of the LES results in the hybrid evaluation with the average of the two controls established in the first semester for group C

Toward the end of this experience, we wanted to measure the percentage of satisfaction of the students in relation to this hybrid evaluation; a sensing established in class showed that most students with a percentage of 85% appreciated this method besides that they voted to take it back in the rest of the summative evaluations; and they justified their choice by the fact that this method allowed them to familiarize themselves with the new technology, it was also an opportunity to speak, to express themselves and to develop oral communication, a point that is not always valid in the normal working conditions. This method favors group work, exchange and collaborative learning that develop autonomy and responsibility; as it puts the focus of the action on the students rather than on the role and power of the teacher [16], as well as helps to better prepare for the summative evaluation and better understand the course.

Moreover, they found it motivating since the mark of the presentation represents 50% of the global mark of the evaluation and according to the literature, the higher the marks, the higher the results of intrinsic motivation, and the lower the marks, the higher the results of motivation [30].

However, 15% who were against this method justified their answer by the fact that it requires more time and effort; that it requires sophisticated tools for filming and editing, and that this experience coincided with the evaluation period in the other subjects and therefore they found it difficult to manage their time in addition to the unavailability of rooms to film the presentations.

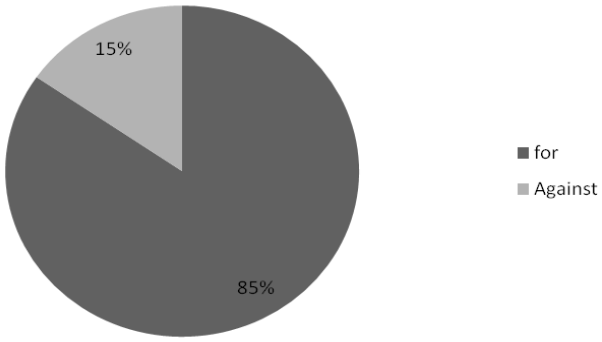

Fig. 6 Percentage of students who were for or against repeating the hybrid evaluation experiment

4. Conclusion

Several studies and works in didactics have talked about the positive impact of the involvement and mobilization of learners in the teaching-learning process. According to [22], the success of learners is linked to their engagement in the school activity especially when this engagement is performed in a collaborative context. A collaborative work develops autonomy and responsibility because it focuses on the students' action rather than the teacher's role and power. This led us to assume that involving learners in the assessment process would likely have a positive impact on their performance and promote the achievement of conceptual change in them. Hence, the objective of our work was to verify this hypothesis through a hybrid evaluation in a collaborative context.

The students of the sample we worked with were invited to produce, in small groups, asynchronous videos summarizing the course they had already received. This gave them the right to make mistakes and to self-correct. To excite their motivation and encourage them to engage effectively in the work, we devoted 50% of the mark to the video, while the remaining 50% was devoted to the written summative evaluation that the students took in class. This is what we call a hybrid evaluation. However, to measure the evolution of the students' performance, we compared the results obtained in the hybrid evaluation to the average of the two tests they took in the first semester of the same school year in life and earth sciences.

According to [29], the group allows sharing the effort and improving the learning of each. Contrary to the authors of [23], who sees that in the case where the groups aim at production (presentation for example), learning is not guaranteed and if they are used to conduct activities set from the outside, they are quickly the place of a division of labor between designers, performers, unemployed and hindrances. Therefore, in order not to fall into the situation mentioned by [23], we insisted on the fact that all students of the same group should speak in the video in an equitable way and to value their work, they should explain the course in the video and not read or recite.

Indeed, the experiment completed gave positive results, both from a quantitative and qualitative perspective, thus answering the problematic posed. In fact, the average of the class in LES went from 13.60 in the first semester to 14.56 in the hybrid evaluation without considering the grade of the presentation; and to 16.33 taking it into consideration. Additionally, the students showed more interest, seriousness and motivation for this method. And to have a clearer idea of the impact of this method on the different categories of students in the sample we worked with; we subdivided the class into three groups A, B, and C according to the results obtained in LES in the first semester.

According to the results obtained, this method did not have a very significant quantitative impact on the results of the students in Group A, since the mark evolved slightly from 18/20 in the first semester to 18.33/20 in the hybrid evaluation without taking the mark of the presentation into consideration, and to 19/20 with it. This is quite normal, since this group has already reached the criteria of excellence, especially since the grade is capped at 20/20. However, we found that this method had a greater impact on the performance of students in groups B and C, where the average of these two groups increased very significantly. Namely, the grade for group B went from 12.69/20 in the first semester to 13.65/20 in the hybrid evaluation without considering the grade of the presentation, and to 15.61/20 taking it into consideration, and for group C it went from 7.81/20 in the first semester to 9.78/20 in the hybrid evaluation without considering the grade of the presentation, and to 13.06/20 taking it into consideration. From a qualitative viewpoint, this experience had a very positive impact on the students in the sample studied; this was highlighted through the quality of the videos they presented. The videos reflected effective mobilization, better understanding of the course, collaboration and greater motivation.

5. Limitations and Further Study

A similar study was conducted on a class of first year Mathematical Sciences Baccalaureate students, but which did not lead to the same results. We can explain this situation, by the fact that the students of this level were followed by a regional certification exam toward the end of the semester, which will be counted in the general mark of the baccalaureate and thus they were more focused on the preparation for the latter, moreover some among them returned the asynchronous presentation after the summative evaluation, knowing that the objective of this method was to prepare for the evaluation through the preparation of the presentation, which influenced the obtained results. These students did not show the same commitment as the core students (the sample studied) who were not concerned with the certification exam, and therefore had more time to devote to the lived experience. This led us to conclude that this method is not applicable for all levels.

Our study was conducted on a small sample of students belonging to the same high school, and therefore to give more validity to this method; we intend, on the one hand, to repeat it with the same sample on a different chapter by introducing ICT during the realization of the course and to see the impact of this parameter on the conceptual change of the learners; and on the other hand to widen our sample by applying the same method on students of common trunks belonging to different high schools.

Finally, this experience allowed us to evaluate parameters that cannot be measured by the classic evaluation, namely the evolution of each student in relation to his initial state instead of comparing and classifying him in relation to the other students of the same group; the team spirit, the initiative, the innovation, the speaking and the oral expression and especially the cognitive conflict that favors the realization of the conceptual change. For this reason, we recommend that teachers apply this method to their students, who do not belong to certification levels, given its positive impact on motivation and on the acquisition of scientific concepts by the students according to this experience.

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