Restrict or Share the Use of the Interactive Whiteboard? The Consequences on the Perception, the Learning Processes and the Performance of Students within a Learning Sequence on Dynamic Geometry

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ABSTRACT
The aim of this study is to analyse the impact of the shared use of the interactive whiteboard (IWB) on the perceptions, learning processes and performance of learners. It was carried out with lower secondary school students within the context of a class on dynamic geometry. The work is based on a set of indicators and the results were obtained from quantitative data, which was collected through a written questionnaire, and from qualitative data, which was collected through encoded video recordings. These results show that sharing the use of the interactive whiteboard has an impact on the perceptions of learners in terms of the usability and usefulness of the tool, that it encourages interactions between the students and that it seems to have a positive effect on the efficiency of the learning sequence itself.

Keywords: Interactive whiteboard, shared use, teaching/learning process, interactions, perception of the learners.

1. TOWARDS 'THOUGHTFUL USE' OF THE INTERACTIVE WHITEBOARD
For over twenty years, many researchers have been studying the use of information and communication technology (ICT) in schools. Several authors (Depover *et al.*, 2007; Karsenti *et al.*, 2002) show that simply using technology does not guarantee its educational effectiveness, while others, including Poyet (2009), indicate that contexts and teaching situations are the key factors for the effectiveness of ICT in teaching practices. Having already been used in companies for many years, interactive whiteboard (IWB) usage has been increasing for several years in classrooms in England, Australia and Mexico. In 2011, in Europe and North America, IWB was one of the most popular technological supports for teaching and learning in different disciplines. Governments, understanding the value of using such tools in the classroom, have already accepted integrating this technology into educational settings. Recently, studies both confirming and refuting the potential impacts of the tool have been conducted, and the results are far from unanimous.

Studies (Miller & al., 2002; Jeunier et al., 2005; Kennewell & Beauchamp, 2007; Lee, 2010 ; Tataroglu & Erduran, 2010; Bidaki & Mobasheri, 2013) show that the use of IWB by students led to both a higher degree of motivation and level of participation, others (Levy, 2002; Wall, Higgins & Smith, 2005; Merrett & Edwards, 2005; Glover et al., 2007; Karsenti, Collin & Dumouchel, 2012) maintain that the motivational effects fade away quickly and are more related to the novelty effect of the tool. Others (Slay *et al.*, 2008) highlight that the originality of the support may be a source of motivation but educational value must be more important to perpetuate its effects. Concerning the quality of learning, here again the results are not unequivocal. Glover and al. (2001) and Becta (2003) indicate that this support does not induce differences in overall performance while others (Somekh et al., 2007) observed an improvement in students' performances.

Few studies to date relate the impact of the ways of using the IWB from an experimental point of view. This study was conducted in an attempt to provide some possible answers to this problematic situation. The effects of a 'shared usage' of the interactive whiteboard with learners in comparison with a 'restricted use' for the teacher are analysed. The objective is to evaluate the impacts of the use and usability of the tool on the progress of the students, the teaching / learning process and the perceptions of learners. The independent variable considered in

this study distinguishes between the use of the IWB being strictly reserved for the teacher in one group and the sharing of the material between the students and the teacher in a second group of learners. Given that the teaching and learning is based on a pedagogical script that integrates the IWB differently, differences on several levels are to be expected.

On the level of the students' perceptions, it can be assumed that the shared use of the support will have a motivational effect in comparison to the teacher only use. It is also expected that the types of privileged interactions during the course will depend on the mode of use of the media. Finally, the hypothesis that the performance between students of the two groups formed will differ will also be considered. In other words, the aim of this study is to identify and compare, in a specific context and with specific mathematical content, the most appropriate conditions for getting the maximum value out of the interactive whiteboard, from a pedagogical point of view.

2. EXPERIMENTAL CONTEXT

This study was conducted at a technical college, as part of a mathematics course which is taught five hours per week to students of the second year of secondary school (about 13-year-old students). A teaching sequence was given to students over five hours. It consisted of a script and three different activities with the IWB. The material chosen for the sequence focused on the axes and centres of symmetry. For the simulation exercise, students were put in pairs and had to form two piles of playing cards. Without instructions or advice, it was expected that students would distinguish the difference between the cards with or without an axis or a centre of symmetry. As mentioned previously, three activities were proposed: the first consisted of asking students to make a line, to complete a representation of letters using orthogonal symmetry, to find the letters in the alphabet having an axis and/or a centre of symmetry and to determine whether the logos presented had one or more axes and a centre of symmetry. The second activity required the students to identify the axes and the centres of symmetry of known geometric figures and then infer proposed rules that can be taken from the case presented. The third activity involved two tasks where students are asked to identify the axes and centre of symmetry of regular polygons. Apart from the differences in the experimental design of the methodology (handling or non-handling of the tool by the student), the course was the same in each class.

3. DISTINCTION BETWEEN THE TWO WAYS OF USING THE INTERACTIVE WHITEBOARD

The aim was to observe the differences in the learning/teaching process and the in performance due to the experimental process itself. Therefore, the teacher had to carefully follow the instructions of the developed pattern. Only differences regarding the methodology were planned. The two groups were formed on the basis of Warren's statement (2002) according to which two ways of using the IWB were mainly implemented by the teachers. The first group (experimental group) consisted of two classes (N=24) of learners who used the interactive tool repeatedly during the lesson (this is called 'shared use of the IWB' with the learners). 'Shared use' of the interactive tool means that all the learners use the interactive whiteboard on a voluntary basis or after being asked by the teacher. Different activities were given to the learners (construction of figures, removal of objects, etc.) in order to confront them with the different possibilities of the IWB. These activities were mainly taken from the book *Actimath* (Bams et al., 2014). The teacher and the students used the manual, which the teacher had digitised in order to make it readable on the IWB. The related CD-Rom was used as a correction tool. While the learner used the IWB, the teacher and the other students were available for confirmation and/or to offer some assistance. There were no restrictions on another volunteer going up to the IWB depending on requests from the others. During the five hours of the experiment each learner used the interactive tool an average of ten times with an average total duration of eighteen minutes. The second group (control group) consisted of one class (N=11) that attended the same course using the same tool. The only difference was that only the teacher used the whiteboard (this is referred to as 'exclusive use of the IWB' by the teacher).
In order to maintain the ecological validity of this study, it was decided to keep the composition of the three classes and to form two different quasi-experimental groups.

4. TEST PATTERN AND METHODOLOGY

Based on the work of Beauchamp & Parkinson (2005) and Cohen (2007), the main hypothesis for this study is that sharing the use of the IWB between the teacher and the students can favourably impact both the perception of the learners and the teaching and learning processes that are implemented during the learning sequence. In other words, this study analyses the impacts of a 'shared use' of the interactive whiteboard on the motivation of the students, on the preferred means of interaction and on performance. A pattern to observe the use of the tool within a real learning context was set up in order to confirm or invalidate the hypotheses. It is based on a quasi-experimental plan which is structured in three successive stages (Table 1). A pre-test was carried out in which the learners were required to perform 8 exercises about axes and centres of symmetry without any precise information about the purpose of the experiment. For the first two sub-exercises, they had to complete the

construction of geometrical figures by using orthogonal symmetry. During the second activity, the learners were shown two road signs. The students indicated if there were one or more symmetrical axes with or without a centre while specifying how many. For the next activity, the students were given two kinds of figures (with secant and parallel segments) on which they had to draw the axis or axes, and in some cases the symmetrical centre. For the last activity, the students had to move shapes and/or segments in a way that the given line(s) corresponded to the symmetrical axis or axes. For each of the sub-exercises a grade was given in terms of raw score. These grades were added up so that a relative gain in performance could be calculated. After that, the teacher gave a five-hour learning sequence based on a pattern with a precise methodology to apply. Finally, all the students performed a 'post-test' using the same protocol applied during the 'pre-test'. The whole experiment was filmed.

Table 1 Test pattern

1. **Pre-test**
- 8 exercises about axes and centres of symmetry (4 exercises consisting of two sub-exercises) - On IWB - video camera - same protocol
2. **Learning script**
- a learning sequence for five hours (based on a pattern with a precise methodology about axes and centres of symmetry (5 hours) - Using book « Actimath » (mathematics book) - Same methodological development in both experimental groups - video camera
3. **Post-test**
- 8 exercises about axes and centres of symmetry (4 exercises consisting of two sub-exercises) - On IWB - video camera - same protocol

Concerning the analysis of the process, all the social activity of students was encoded based on a video recording of the full lesson. Six indicators were considered: number of questions asked per student, number of answers given, number of remarks, number of interactions between the students in the class, number of interactions between a student in the class and a student at the IWB, and number of times each student raised their hand. The aim of this content analysis was to recognise these events for each student, irrespective of length, and then to record this information in a database.

5. DEPENDENT VARIABLES AND RESEARCH HYPOTHESES

The aim of this study is to analyse the impact of the independent variable, shared or restricted use, on three dependent variables: the perceptions, the processes and the performance (variables). Table 2 presents the distinction between these variables, the indicators associated with these variables and the different ways of collecting the data.

Table 2 Dependent variables, indicators and sources of the observation

Variables	Indicators	Sources of the observation
Perception- *Usability of the tool*	Learning Controllability Clarity Flexibility Skilfulness Usability	Adaptation and translation of the opinion survey of Davis (1989)
Usefulness of the tool	Helps to understand the material Helps to improve the quality of the work	Questionnaire concerning the usefulness of the tool
Motivation	Admitted motivation	Questionnaire on the motivation of the students
Process-	Average number of questions asked per student	Observations made in class

Social interactions of the students	Average number of answers given per student Average number of remarks made per student Average number of interactions between the students Average number of times hand raised per student Average number of interactions of the students with the person at the IWB	recorded with a video camera
Performance- *Progress of the students*	Scores in terms of relative gains per student	Analysis of the "pre-test" data Analysis of the "post-test" data

5.1. Hypothesis 1 – The usability and usefulness of the IWB gives the students a better grasp of the taught lesson and allows them to improve their learning

The first research hypothesis (H1) is about the perceptions of the learners according to two complementary dimensions. For this the learners had to be asked about the usability of the tool. Therefore, the translated version of Davis's survey was used (1989)[1]. Six criteria were selected in order to evaluate the usability of the tool: the Learning, the Controllability, the Clarity, the Flexibility, the Skilfulness, and the Usability. Each student had to choose an answer from a seven-point Likert scale (Strongly disagree – Disagree – Disagree somewhat – Undecided – Agree somewhat – Agree – Strongly agree). Learners were also asked about the usefulness of the tool for teaching/learning.

5.2. Hypothesis 2 – Sharing the use of the IWB gives more motivation to the students in comparison with an exclusive use of the tool by the teacher

All the students participating in the experiment were invited to evaluate several statements about their motivation level in order to confirm or invalidate this second hypothesis (H2).

5.3. Hypothesis 3 – Sharing the use of the IWB had an impact on the learning processes that were implemented during the learning sequence.

The variable called 'social interactions of the learners' was taken into account to test this third hypothesis (H3). The learning sequences were recorded and different indicators were selected to code all the interactions of the class (Bouchard & Mangenot, 2001) in order to observe the learning dynamic that had occurred during the courses. Based on the work of Sinclair & Coulthard (1992), each of the noted actions were classified into specific categories (questions asked by a student, answers given by a student, remarks by student, interactions between learners, times students raised their hands, open questions to the students, closed questions to the students, open questions to a student, closed questions to a student, given answers, remarks to the students and remarks to a student). Then, the video recordings and analyses made it possible to precisely encode the different interactions observed during the courses. In order to more easily compare the interactions between the groups, the results are presented in terms of average numbers.

5.4. Hypothesis 4 – Sharing the use of the IWB influences the homogeneity of the students in terms of performance.

The fourth research hypothesis (H4) is based on the theoretical model of Mayer (2010) according to which the quality of learning, including the use of technological material, increases as the student activity increases. The aim of the hypothesis is to find how an interaction method impacts on the progress made by the learners and to evaluate the homogeneity of the performance of the learners. The relative gains in their performance was calculated in order to assess the progress of the learners and to compare the performance of each group in the same way. These calculations were made using the formula described by D'Hainaut[2] (1975) which made it possible to have a comparison between the student's 'actual attainment' and what was calculated to be the 'best possible' attainment. So, the results of the 'pre-test' and 'post-test' meant that performance could be measured in terms of relative gains. These tests were carried out with all of the learners on an interactive support in order to evaluate them on a tool identical to that used for the lesson (Devauchelle, 2008). As previously mentioned, the analysis procedure of the performance, by means of 'pre-test' and 'post-test', consisted of an evaluation of four activities each made of two similar sub-exercises.

[1] The questionnaire, which was administered at the end of training, also included two items to assess the students' motivation in relation to their learning.

[2] The formula to calculate the relative gains is (Result post-test – Result pre-test) / (Maximum result – result pre-test) x 100.

6. ANALYSIS OF THE RESULTS

6.1. Analysis of the results concerning the usability and usefulness of the tool (H1)

Table 3 Descriptive statistics – Opinion of the learners according to the usability of the IWB (%)

Usability	Overall % of unfavourable opinions	Unfavourable opinions			Undecided	Favourable opinions			Overall % of favourable opinions
		Strongly disagree	Disagree	Disagree somewhat		Agree somewhat	Agree	Strongly agree	
Q 1 (Learning)	45.3	**22**	11	10.5	8.5	11	19.5	17.5	48
Q 2 (Controllability)	39	4	6.5	28.5	8.5	6	**40**	6.5	52.5
Q 3 (Clarity)	26	8.5	10.5	7	2	**31**	28	13	72
Q 4 (Flexibility)	40	18	5	17	11	10	**31**	8	49
Q 5 (Skilfulness)	31	4.5	9	17.5	6	20	18.5	**24.5**	63
Q 6 (Usability)	32.5	13	11	8.5	7	**26**	21.5	13	60.5

Table 3 highlights the differences of opinions in the groups that were used to carry out the experiment on the usability of the interactive whiteboard. In order to better understand the results, the overall percentages of unfavourable and favourable opinions are shown (Table 4). In this way, 68.5% of students from the group 'shared use of the IWB' answered the first question (Q1) favourably whereas 63.75% of the learners from the group 'exclusive use of the IWB' answered the same question unfavourably. For the question about the Controllability (Q2), 68.5% of students from the group 'shared use of the IWB' gave a positive response while 54.5% of the respondents from the other group gave a negative answer. While 73% of the learners from both groups agreed on a favourable answer to the third question (Q3) about Clarity. From the group which did not use the interactive tool during the learning sequences 54.5% answered the fourth question (Q4) about Flexibility favourably, with 44% of the learners from the other group expressing a favourable opinion about the same question. In answer to the fifth question (Q5) about Skilfulness, 80% of students from the group 'shared use' of the interactive whiteboard gave a favourable response and 54.5% of the learners from the group 'exclusive use of the IWB' gave an unfavourable answer to this question. With percentages under 50% for both favourable and unfavourable opinions, it appears that the students who could not use the tool during the course did not have a strong view about the sixth question (Q6). However, a large majority (76.5%) of the learners from the group 'shared use of the IWB' gave a favourable answer to this question.

The inferential analysis (Table 4) shows two significant differences between both groups (Q.1. M. – W. = 26.000; p. = **.021**; Q.5. M. – W. = 29.500; p. = **.038**). It must be noted that the students who made direct use of the tool gave a more positive opinion in terms of learning and skilfulness.

Table 4 Descriptive and inferential statistics – Opinion of the learners according to the usability of the IWB (%)

Usability		Unfavourable opinions			Undecided	Favourable opinions			M. – W.	p.
		Strongly disagree	Disagree	Disagree somewhat		Agree somewhat	Agree	Strongly agree		
Q. 1.	exclusive use of the IWB	**36.5**	18.25	9	9	18.25	0	9	26.000	**.021**
	shared use of the IWB	7.5	4	11.5	8.5	4	**38.5**	26		
Q. 2.	exclusive use of the IWB	0	9	**45.5**	9	0	36.5	0	33.500	**.070**
	shared use of the IWB	7.5	4	11.5	8.5	12	**43.5**	13		
Q. 3.	exclusive	9	9	9	0	**36.5**	27.5	9	57.000	.812

	use of the IWB									
	shared use of the IWB	8.5	12	4.5	4	25	**29**	17		
Q. 4.	exclusive use of the IWB	18.25	0	18.25	9	9	**36.5**	9	52.500	.591
	shared use of the IWB	17.5	10.5	15.5	12.5	11	**26**	7		
Q. 5.	exclusive use of the IWB	9	18	**27.5**	0	**27.5**	0	18	29.500	**.038**
	shared use of the IWB	0	0	7.5	12.5	12.5	**36.5**	31		
Q. 6.	exclusive use of the IWB	18.25	18.25	9	9	**36.5**	9	0	32.500	**.060**
	shared use of the IWB	7.5	4	7.5	4.5	15.5	**34.5**	26.5		

Concerning the usefulness of the interactive tool (Table 5), all the opinions of the students were favourable regardless the group. In fact, all the learners who did not use the tool gave a positive opinion and said that the interactive whiteboard helps to understand the academic content being taught. Moreover, when the percentages of favourable opinions are added together, the findings show that 92% of the learners from the group 'shared use of the IWB' agree with them. In the same way, it can be noted that 96% of the members from the group 'exclusive use of the IWB' gave a favourable answer to the proposition about improving the quality of work according to the use of the tool compared with more than 72% of students that used the tool during the learning sequence.

Table 5 Descriptive statistic – Opinion of the learners according to the usefulness of the IWB (%)

Usefulness		Groups	Unfavourable opinions			Undecided	Favourable opinions			Overall % of favourable opinions
			Strongly disagree	Disagree	Disagree somewhat		Agree somewhat	Agree	Strongly agree	
Item 1	Do you think that the IWB helps you to better understand academic content?	exclusive use of the IWB	0	0	0	0	18	**45.5**	36.5	100
		shared use of the IWB	0	0	4	4	12	39	**41**	92
Item 2	Using the IWB would improve the quality of your work.	exclusive use of the IWB	9	0	0	18.25	9	18.25	**45.5**	**72.75**
		shared use of the IWB	0	0	0	4	36.5	**38**	21.5	96

There is no significant difference of opinions among the groups (Item 1: M. – W. = 130.500; p. = .954; Item 2: Mann-Whitney[3] (M. – W.) = 131.000; p. = .970) concerning the inferential statistic. Having used the tool or not does not seem to influence the perceptions of the students as far as the usefulness of the tool is concerned. In fact, regardless of the way of using it, it appears that the interactive tool helps to have a better idea of the material and improves the quality of the work being done.

[3] Mann-Whitney is a non-parametric test to compare two independent samples of small size.

6.2. Analysis of the results on the motivation of the learners (H2)

Two items of the questionnaire, provided at the end of the educational sequence, were about the motivation of the learners (Table 6). The first item shows that sharing the use of the tool influences the level of motivation of the learners. So, while 73% of the members from the group 'exclusive use of the IWB' brought up the fact that their motivation did not change when the teacher used the interactive whiteboard on their own, 54% of the learners from the other group recognised that their motivation decreased significantly in the same situation (p=.018). The students who shared the use of the tool expressed that they felt that the situation was less relevant if the interactive whiteboard was used in a traditional way. For the second item, the views converge as far as the shared use of the interactive whiteboard between the learners and the teacher (p=.784) is concerned. In fact, the majority of the students in both groups said that their motivation for attending the course increased in such a teaching and learning context. For this item, 45% of learners from the group 'exclusive use of the IWB' said that their motivation decreased in such conditions while 25% of students from the group "shared use of the IWB" said that this did not influence their motivation.

Table 6 Descriptive and inferential statistics – Motivation of the learners

		Way of using	More motivated	Less motivated	It does not change your motivation	M. – W.	p.
Item 1	When your teacher teaches mathematics while using the interactive whiteboard on its own, you are…	Exclusive use of the IWB	9	18	73	70.500	**.018**
		Shared use of the IWB	21	54	25		
Item 2	When your teacher teaches mathematics while using the interactive whiteboard and you are invited to use it , you are…	Exclusive use of the IWB	54	45	0	125.500	.784
		Shared use of the IWB	71	4	25		

6.3 Analysis of the results about the learning processes (H3)

Figure 1 shows the average amount of social interaction, for a learner, according to both experimental groups. There are noticeable differences between the averages of both groups regarding the targeted social interactions. On the whole, the results are in favour of the group 'shared use of the IWB'. The group of learners that did not share the use of the tool got a higher average ($x= 37.27$; $\sigma = 25.09$) in comparison with the other group ($x= 36.21$; $\sigma = 24.83$) but for only one variable, the 'average number (x) of answers per student'. In other words, it appears that the group sharing the use of the interactive whiteboard exchanged and shared more information than the group that could not use the tool during the courses.

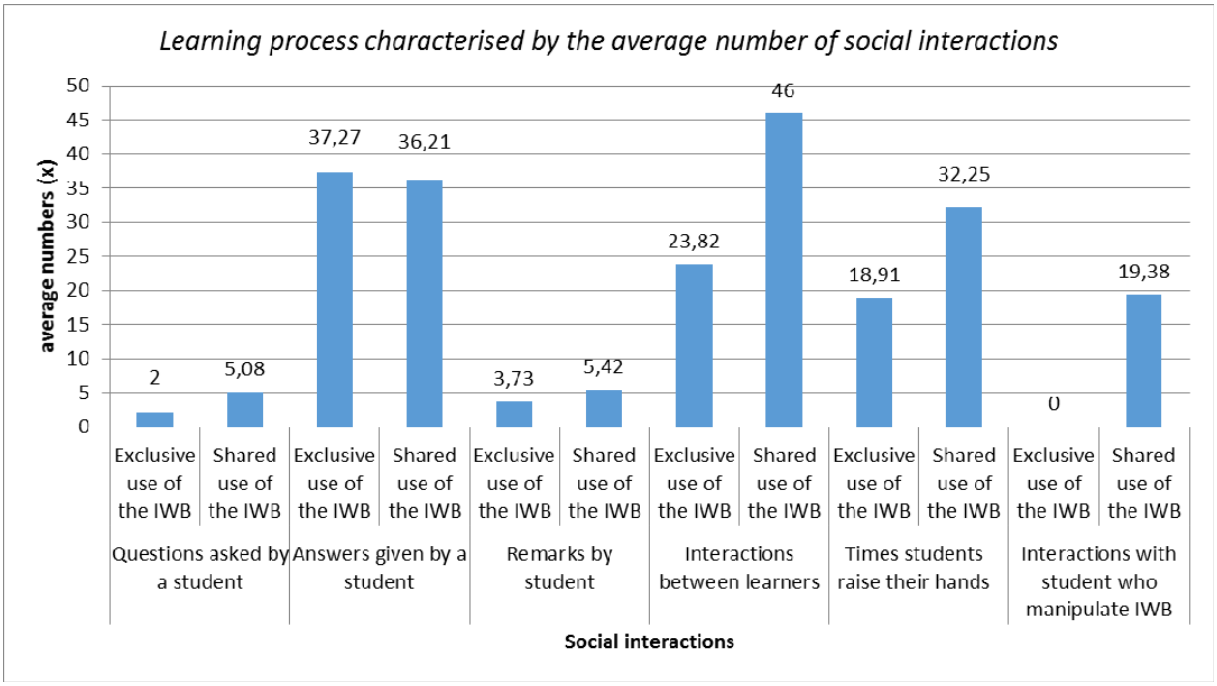

Figure 1 Descriptive statistics – learning process characterised by the average number of social interactions which were noted during the learning sequences

Thanks to the learning process analysis, it appears that the students who shared the use of the interactive whiteboard interacted more in comparison with students who could not use the tool directly. This statement has been statistically confirmed. There are indeed very significant differences in terms of average numbers (x) between both groups consisting of the targeted interaction types for the majority. Therefore, the students using the interactive tool asked the teacher more questions than the learners from the group 'exclusive use of the IWB' (t= -2.189; p. = .018). This result is an interesting indicator which suggests that students using the tool actively are more interested in, and motivated by, participating in the lesson. This statement is in line with the observations of other studies (Jeunier et al., 2005; Leroy, 2007) since they say that the use of the IWB by students increases their motivation and, therefore, their participation. Moreover, the learners who could share the use of the tool interacted more with each other than those for whom the use of the interactive whiteboard was limited to the teacher (t= -3,438 ; p. = .001). Thanks to the analysis of this learning process, therefore, it appears that the method which consists of sharing the use of the tool is an interesting lever to stimulate a learning activity based on the IWB. As noted in Cohen (2007) and Beauchamp & Parkinson, (2005), this study found that an educational mediation of the teacher between the whiteboard and the students encouraged collective work between the students and developed the contribution of others in the group. As well as the interactions between each other, students from the group 'shared use of the IWB' did not hesitate to help the learners using the tool and to interact with them (t= -5.272; p. = .000). The high significance of the difference between the groups, for this indicator, is due to the experimental plan and lies in the fact that only the students from the group 'shared use' had the possibility to develop these kind of interactions. The observations showed that the interactions mainly concerned the techniques for using the IWB to be able to cognitively perform the proposed exercises in the second phase.

6.4 Analysis of the results about the progress of the learners (H4)
From Table 7, a difference in the limit of the significance between the averages of both groups in terms of relative gains is observed.

Table 7 Descriptive and inferential statistics – Progression of the learners

modes of use of the IWB	**Pre-test**			**Post-test**			**relative gains**		
	average	CV		average	CV		average	CV	
exclusive use of the IWB	11.09	.43	t= -0.45 p = .482	15.82	.18	t= -1.69 p = .050	44.00	79.11	t= -1.60 p = .059
shared use of the IWB	11.17	.40		17.23	.11		61.88	46.26	

The learners sharing the use of the interactive whiteboard made more progress in the mastery of the skills up to 61.88% in comparison to the other group which was not allowed to use the tool and of which the average is 44.00%. If considering the dispersion of the results while observing the degrees of heterogeneity (CV) of the pre-test and post-test, there was a positive effect of the educational sequence on the homogeneity of the results whatever the way the IWB was used. If considering the difference between the modes of use, it is noted that the results of the learners for the post-test with the condition 'shared use' are more homogeneous (CV= .11) than those with the condition 'exclusive use' (CV= .18). In terms of intrinsic efficiency, a more participative educational management of the IWB leads to benefits both on the progress of the students and the level of heterogeneity of a group.

7. DISCUSSIONS, CONCLUSIONS AND PERSPECTIVES

The results achieved at the end of this study help to understand, to a certain extent, the lack of potential benefits from the contribution of the interactive whiteboard in recent meta-analyses (Karsenti, Collin & Dumouchel, 2012).

This study shows that a 'shared use' of the IWB has an impact on the learning and teaching process. The observations made in a similar context, in accordance with the premise 'all things being equal', gives the opportunity to see that sharing the use of the interactive whiteboard influences the quantity and types of favoured interactions. In this teaching situation, there were more social interactions in the classroom in comparison with an exclusive use of the board by the teacher. Furthermore, the teacher acted more individually when they shared the use of the tool with the students. This means that the teacher could observe the work of the students in real-time and had more possibilities to better regulate the learning process while advising the students and guiding them to perform the exercises. Several studies (Wood & Ashfield, 2008 ; Jeunier et al., 2005; BECTA, 2003) argue that the potential of the tool lays the groundwork for educational methods in greater accordance with the needs of the learners. However, it could be considered that the condition for an educational use of the tool, more than the tool itself, leads to a more differentiated teaching (Duroisin et al., 2011). The analysis of the declared level of motivation and the perceived usability corroborates this observation at the process level.

With regards to the educational efficiency of the mode of use of the IWB, the progress of the students is greater when they have the opportunity to share the use of the IWB and this can be explained by their greater commitment to the activity. Although this difference in terms of progress does not appear to be as significant on a statistical level, this analysis also shows a greater homogeneity of performance for those learners. It appears that sharing the use of the interactive tool considerably lightens the dispersion of the averages of all the learners from the group. This result is interesting insofar as it shows that different educational use of the IWB can have a positive effect on the level of heterogeneity of a group, which is often difficult for the teacher to achieve. Being exposed to content is therefore not enough to learn. It has to be backed up by a real thought in terms of tasks given to the students in order to facilitate the development of the targeted skills. This idea is perfectly coherent with the model of Mayer (2010) according to which the human factor is a key-variable to get a positive impact from the technology supporting learning if pertinent choices are made in terms of educational implementation.

At the end of this experiment and in light of the results presented, it can be considered that a well thought out, shared use of the interactive whiteboard has to be favoured if the learners participate actively and if the teacher is capable of mobilising the interactive potential of the tool. As this study has shown, giving the teacher exclusive of the tool has limited effects. However, as previously suggested, the perfect solution does not exist. The quality of the use of the tool and the given lesson essentially depends on the underlying thought process. Last but not

least, it should be noted that other dependent variables could also be taken into account. Additional measures which could be taken into consideration for further studies are things such as efficiency, the differences in the general performance and the precision between the productions made on paper or on an interactive whiteboard, the use of traces and the number of multimediatised resources used. This could help to better understand the learning dynamics around the interactive whiteboard. In terms of perspectives, it is important to further investigate the modes of participation of the students within a learning sequence including the use of the IWB. From the information available it seems that not many empirical investigations have evaluated interactivity on the whole, when the students have the opportunity to participate with the direct help of communication tools. These tools could be handheld voting devices or digital tablets which are equipped with specific software in order to manage the information flow between the teacher and the students.

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